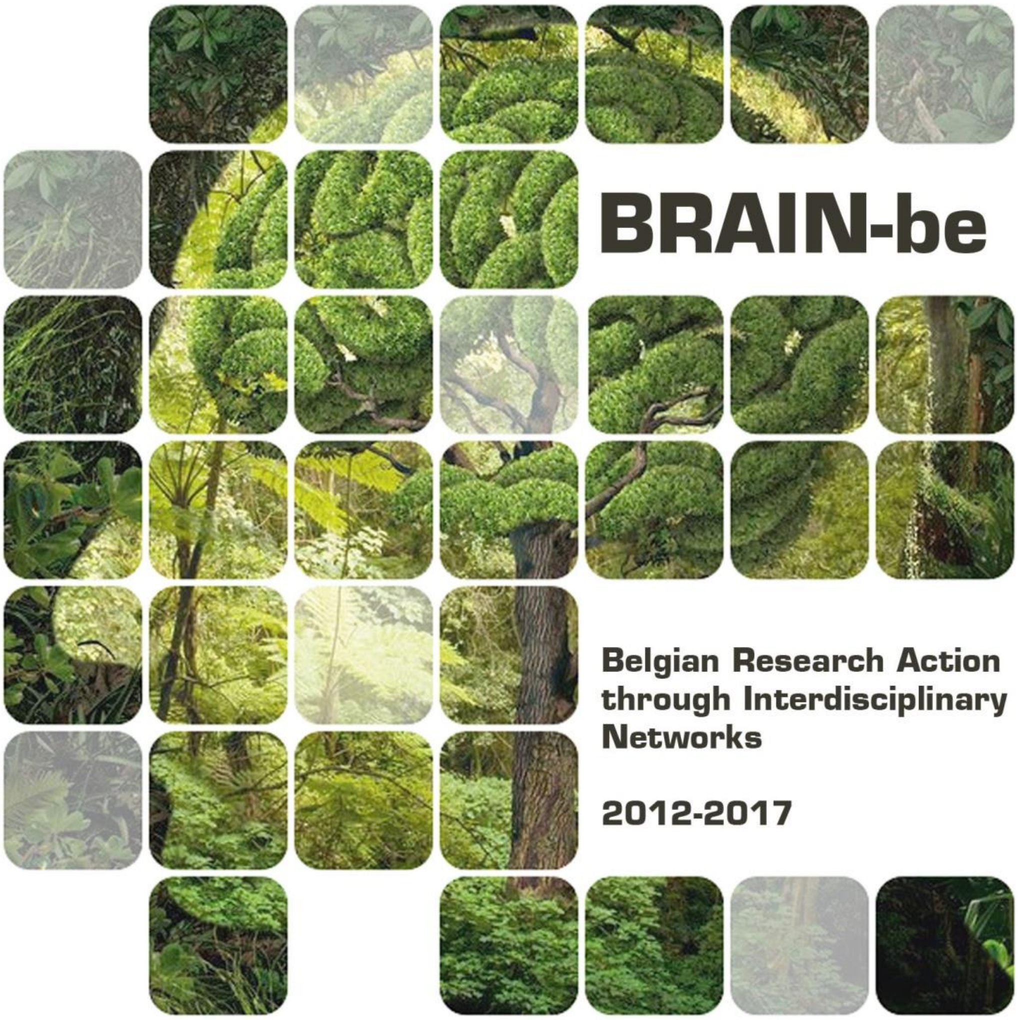

SUSPENS

Reconciling environmental and social goals in the transition towards a low-carbon society

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Axis 5: Major societal challenges

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NETWORK PROJECT

SUSPENS

Reconciling environmental and social goals in the transition towards a low-carbon society

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FINAL REPORT

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ABSTRACT

The transition to a low carbon society will generate major economic and social consequences. The overall aim of the SUSPENS project is to gain a proper understanding of the interrelationships and potential trade-offs between environmental and social goals in the transition to a low-carbon society in Belgium. This general aim is split up along theoretical, methodological and empirical tracks.

On the theoretical level, the SUSPENS project discusses the diverse literature strands dealing with socio-environmental inequalities, the role of households and their consumption; and how social and environmental objectives can be integrated in policy design. Methodologically, the PEACH2AIR database was constructed, allowing us to study the interrelationships between income, consumption and greenhouse gas emissions in an integrated way at the micro-level of the household. Empirically, we assessed the Belgian governance context against principles of justice; mapped the relation between income and other household characteristics, consumption and greenhouse gas emissions across the Belgian population; and analysed social and ecological outcomes of case studies in the domain of food, housing and a carbon tax-and-dividend.

We find that the climate problem is entrenched with social inequality. The "double injustice" (those who contribute least to climate change are most vulnerable to its effects, which holds both at a global level and within nation states) becomes a "triple injustice when climate policy negatively affects the disposable income of poor households relatively more than that of rich households. When climate policies in their design do not take into account the social heterogeneity of the target group, we indeed often observe socially regressive effects. The review of the energy foresight studies carried out for Belgium reveals that, currently, justice issues are hardly addressed in the analyses of low-carbon transition pathways. The challenge that policy faces is therefore to shape a bold climate policy in such a way that it will be able to meet the challenges without increasing inequality. Our case studies in the different policy domains indicate that the multiple synergies between the social and environmental dimension of sustainability can even be a powerful lever to reduce social inequalities and strengthen inclusion within the transition to a post-carbon society.

Keywords:

climate policy, social inequality, just transition, emissions from household consumption, socio-ecological policy.

1 INTRODUCTION

Climate change and social inequality are among the greatest challenges of the 21st century. This is not only stated by 'social progressives' (e.g. Fleurbaey et al. 2018), but is also more and more part of the common perspective of more traditional institutions such as the International Monetary Fund[1], the European Commission[2] and an increasing number of political and economic think tanks[3]. Moreover, climate change and inequality are strongly linked. After all, the climate issue is to a large extent a distribution issue, with a strong interaction between inequality, emissions and climate policy (see also Chancel 2017). Vicious dynamics between climate change and social inequalities take place both at global level (between rich countries and poor countries) and between different groups within countries (between rich and more vulnerable population groups), and they reinforce each other without always being identified as such.

The transition to a low carbon society will generate major economic and social consequences. While environmental, social and economic objectives are traditionally pursued separately and with distinct policy instruments, the concept of sustainable development (as developed by the “Brundtland Commission”, cf. WCED 1987) provides a useful framework to characterize the inherent interrelations between redistributive challenges – situated in the social dimension – and low carbon aims (environmental dimension), within an explicitly long-term, intergenerational frame of reference. It has been argued that the key challenges of sustainable development arise at the junctures of its three dimensions (Campbell 1996, Lehtonen 2004). The SUSPENS projects zooms in on the social-ecological axis, starting from the observation that the costs and benefits from policy responses to climate change are far from neutrally distributed (e.g. Büchs et al. 2011).

In order to prevent low-income households from bearing a disproportionate share of the cost of environmental policies, governments can deploy three strategies (Serret, Johnstone, and OECD 2006). 1) To prevent the poor from spending a larger share of their budget than the rich, an environmental tax can be introduced and a rebate offered to low-income people. 2) A redistribution mechanism can be set up through differentiated pricing according to income groups. 3) Certain groups can be exempted from the measure. Many studies have shown that economic instruments are often regressive, such as a carbon tax or subsidies to acquire low carbon products (e.g. low consumption appliances and cars, photovoltaic panels). However, the progressive or regressive effects of a measure depend on the social groups considered. For example, fuel taxation is progressive up to average incomes, but the tax is regressive for all income levels if only car-owning households are taken into account (OECD 2008). The case of transport is particularly complicated in Belgium because a large proportion of the fleet is made up of company cars due to advantageous tax measures, which can be assumed to be regressive.

[1] See for example https://www.imf.org/external/np/fad/inequality/ or https://www.imf.org/external/np/fad/environ/index.htm.
[2] E.g. https://ec.europa.eu/social/BlobServlet?docId=21396&langId=en.
[3] For the EU, see e.g. Bruegel (2019); for the US, see Holmberg, S. (2017).

The overall aim of the SUSPENS project is to gain a proper understanding of the interrelationships and potential trade-offs between environmental and social goals in the transition to a low-carbon society in Belgium. This general aim is split up in specific objectives along a theoretical, methodological and empirical track.

On the theoretical level, the SUSPENS project aims to (1) bring together and discuss the diverse literature strands dealing with socio-environmental inequalities and to develop a coherent multi-dimensional conceptualisation of the interrelationships between these inequalities; (2) conceptualise the role of the household as understood in practice theory, as well as (3) an understanding of how to look at consumption; (4) contribute to the development of a new policy paradigm that integrates social and environmental objectives in policy design. We position the SUSPENS-work in the literature in this Section 2, while the scientific output related to these topics will be discussed in Section 4.

Methodologically, the project aims to improve the existing research infrastructure by (1) building a database that allows for studying the interrelationships between income, consumption and greenhouse gas emissions (and other types of air pollution i.e. emission of particulate matter, photochemical and acidifying gases) at the micro-level of the household; while also documenting the limits and limitations of what we can do with available data and modelling techniques in order to jointly assess distributive and environmental impacts of a range of socio-environmental policy packages, (2) employing multiple case studies analysing if and how various energy foresight studies carried out for Belgium address justice issues. This is described in Section 3.

Empirically, the SUSPENS project aims to increase our understanding of the potential trade-off between the social and environmental dimension of the transition to a low-carbon society by: (1) Assessing the Belgian governance context against principles of justice; (2) mapping the relation between income and other household characteristics, consumption and greenhouse gas emissions (and other types of air pollution i.e. emission of particulate matter, photochemical and acidifying gases) across the Belgian population; (3) analyzing social and ecological outcomes of case studies in the domain of food, housing and carbon taxation. This will be discussed in Section 4.

2 STATE OF THE ART

This section summarizes in more detail the state-of-the-art for the more theoretical topics covered within the SUSPENS project. The actual research findings that built further upon this, are taken up in Section 4.

2.1 Conceptualizing socio-environmental inequalities – a justice perspective

Why is it interesting to evaluate the distributive impact of environmental policies? What is this principle of justice that is at the root of our questions? Which justice do we want for a low carbon society? Justice must be done to both social and environmental issues. And this must be achieved within the framework of a degrowth of energy use: all low carbon scenarios compatible with a moderate climate change display a huge reduction in energy consumption.

Greenhouse gas (GHG) emissions reduction policies can not only reinforce existing social inequalities, but also create unprecedented forms of inequality (McCauley et al. 2019; Forsyth 2014; Bauler and Fransolet 2014; Curran and Tyfield 2020). McCauley et al. explain that "the new injustices of the low carbon energy transition are only emerging, many of which are not yet evident to policymakers or researchers" (McCauley et al. 2019, p. 916). Interactions between ecological and social justice objectives as part of low-carbon transition processes are actually very complex and deserve particular attention (Williams and Doyon 2019; Jasanoff 2018; Sovacool and Dworkin 2015; Forsyth 2014). It is necessary to "critically examining who is (and who is not) part of these processes, who wins and who loses, and recognizing the historical exclusion of peoples and worldviews" (Williams and Doyon 2019, p. 144) in order to ensure a just transition. From a normative perspective, ensuring a just transition is essential because an unjust transition is simply not sustainable. Moreover, from a purely instrumental point of view, a low-carbon strategy that does not take social justice issues into account can potentially result in strong resistances from actors who considers themselves prejudiced, which can constitute an impediment to successful implementation of the strategy in question (Williams and Doyon 2019).

The concept of justice has been much debated, contested and redefined (Sandel 2010). In the following, we understand justice as a "fair, equitable, and respectful treatment of humans, other species, and the environment" (Williams and Doyon 2019). A just transition can therefore be defined as a fair, equitable and respectful process of moving towards a low- or zero-carbon society (Heffron and McCauley 2018). Various strands of literature address this issue, as shown by Williams and Doyon (2019) who explore how the interactions between low-carbon and justice are taken into consideration by different bodies of literature. The three major fields dealing with the questions of justice in low-carbon transition processes are climate, energy and environmental justice literatures. These three research areas conceptualize justice for transitions in distinct ways and focus on different facets of the problem (Williams and Doyon 2019; Heffron and McCauley 2018; Jenkins 2018; McCauley and Heffron 2018; Heffron and McCauley 2017; McCauley et al. 2013).

The concept of **environmental justice** has over the past decades evolved to cover a broader spectrum of issues than the question of the distribution of local environmental nuisances and pollution. This includes problems such as inequalities of access to urbanity, living environment, transport, health and food, as well as inequalities of participation and interpellation of public action on the experienced inequalities (Laigle 2018; Jenkins 2018; Schlosberg 2007). A diversity of conceptions of justice can be observed within the social movements organizing around environmental justice, but also within the scholarships dealing with this question. The researchers are indeed influenced by social movements in defining their own definition of environmental justice (Ballet, Bazin, and Pelenc 2015; Schlosberg 2007). The concept of **climate justice** emerged in the 1990's and evolved alongside environmental justice (Williams and Doyon 2019; Jenkins 2018; Heffron and McCauley 2017). By "(1) asking who benefits from CO_2 emissions and how should they bear the burden for mitigation, (2) recognizing the vast divergence in capabilities to respond to global climate change, and (3) addressing the issue of adaptation, the burdens of which are unequally focused on the world's poor", the concept of climate justice deals with the "triple inequity" of mitigation, responsibility and vulnerability associated with climate crisis (Jenkins 2018, p. 118). It gives attention to issues that are not or hardly addressed in environmental justice community, namely justice for people in developing countries and future generations. **Energy justice** is the more recent concept and started to become an object of study in early 2013 (Heffron and McCauley 2018). This branch of literature focuses on justice issues across the energy life-cycle (from cradle to grave), both from a production- and consumption-based perspective (Heffron and McCauley 2018; McCauley and Heffron 2018). It deals with issues such as the distribution of burdens of the energy system, the access to modern energy devices, infrastructures and services, as well as the representation and inclusiveness in the energy decision-making processes (McCauley et al. 2019; Sovacool et al. 2017; Sovacool and Dworkin 2015). While environmental and climate justice are mainly based on a socio-ecological approach, energy justice introduces a socio-technical perspective on transition justice (Williams and Doyon 2019). In light of the respective strengths and limitations of each approach, several researchers call for developing a more inclusive framework based on climate, energy and environmental justice literatures (Williams and Doyon 2019; Heffron and McCauley 2018; McCauley and Heffron 2018). Such integratory work is particularly challenging because of the diversity of the understandings of the concept of justice between climate, energy and environmental justice communities, but also within each community. The work for linking these three justice communities are still in their infancy – very few contributions being currently available. A particularly interesting attempt to unite climate, energy and environmental justice is the "JUST" Framework developed by Heffron and McCauley (2018). Based on a legal geography approach, the authors connect the three justice approaches via the spatial and temporal dimensions. As shown in the figure bellow (Figure 1), the JUST Framework considers that, for a given event, climate, energy and environmental justice become relevant at a different time and scale. For instance, climate justice is relevant for exploring long-term global impacts on justice, while energy justice is relevant for analyzing short-term local implications on justice (Heffron and McCauley 2018).

Figure 1. The use of energy, environment and climate Justice for event analysis (Heffron & McCauley 2018)

↓ Event Timeline ↓		
(1)Event planned & happens	**(2)Damage occurs**	**(3)Future Impact (& which is far away)**
↓ Form of Justice researched ↓		
(1)Energy Justice	**(2)Environmental Justice**	**(3)Climate Justice**
↓ Event Time & Impact ↓		
(1)Short-term	**(2)Medium-Term**	**(3)Long-term**
↓ Space (i.e. location)* ↓		
(1)Local	**(2)National**	**(3)International**
*all events will have a local, national, international element to them but in general the public will interact more with events that concern societies just transition to a low-carbon economy as this will impact on their income and wellbeing to a greater extent		
Diagram Explanation All the #1s are related as are the #2s and the #3s		

Liberal theories of justice such as the one developed by Rawls in 1971 used to focus almost exclusively on the distribution of social good in the society. Today, justice theories often refer to a wider perspective than just how goods are distributed. Most of the contemporary theories of justice – including the ones developed in climate, energy and environmental justice literatures – consider **three forms of justice: distributional, recognition and procedural justice** (Williams and Doyon 2019; Heffron and McCauley 2017; Bouzarovski and Simcock 2017; Jenkins et al. 2016; Ballet, Bazin, and Pelenc 2015; McCauley et al. 2013; Schlosberg 2007). Distributional, recognition and procedural justice has been identified by McCauley et al. (2013) as the “triumvirate of tenets”.

First, justice is distributive when it analyses the unequal distribution of information, impacts and responsibilities. Applied to low-carbon transition, distributive justice concerns issues such as the allocation of environmental ills and benefits (and their associated responsibilities), natural resources, as well as energy devices, infrastructures and services (McCauley et al. 2019; Williams and Doyon 2019; Jenkins et al. 2016; Sovacool and Dworkin 2015; McCauley et al. 2013). Second, justice is about recognizing a problem or population when it pays attention to disqualifications, insults and degradations that devalue one social group or place in comparison to others. It is about the recognition of pluralist needs, values, interests, issues and solutions in the social and political realms (Williams and Doyon 2019; Jenkins et al. 2016; McCauley et al. 2013; Schlosberg 2007). This form of justice aims at making sure that marginalized and vulnerable groups have special consideration (Sovacool et al. 2017; Ballet, Bazin, and Pelenc 2015). Thirdly, justice is participatory when it is careful to include in its decision-making procedures the parties who demand it. Procedural justice concerns fairness in the procedures according to which decisions are made (Williams and

Doyon 2019; Sovacool et al. 2017; Bouzarovski and Simcock 2017; Jenkins et al. 2016; Schlosberg 2007). It requires quality transparent information disclosure by government and businesses, local knowledge mobilization for defining the political problem and its solutions, and both formal and informal forms of participation in decision-making processes around environmental and social issues (Jenkins et al. 2016; Ballet, Bazin, and Pelenc 2015; Sovacool and Dworkin 2015; McCauley et al. 2013). Procedural justice points to unfair distribution of multiple wealth-related powers (Boyce 2008; Berthe and Elie 2015): 1) Purchasing power that allows the wealthiest to escape environmental degradation or to adapt to a changing environment – which is possible because many aspects of the environment are not public goods and can therefore be privatized; 2) Decision power to influence debates with public and private actors; 3) Agenda power to put issues on (or take them off) the agenda of decision-makers; 4) Value power to shape the social norms and preferences of others to match one's own; 5) Event power to change the environment to which others must adapt - by polluting a place, for example. The distributional, recognition and procedural justice are highly interlinked (McCauley et al. 2013; Schlosberg 2007).

Section 4.1 contains the empirical evaluation of low-carbon scenarios developed in Belgium from the justice perspective lined out above.

2.2 Household consumption as social practices: implications for climate policy

For the objective of understanding the role of the household actor in the context of consumption-related emissions and socio-ecological inequalities that stem from it, we discuss household consumption through the lens of the social practice approach. This alternative way of understanding household consumption differs from the way consumption is usually conceptualized in the policy debate. While we treat the starting points here, the results section 4.2. outlines the implications for policy measures aimed at bringing about the transition to a low-carbon society in the context of a welfare state such as ours, in which both social and environmental objectives will be pursued.

For this purpose we take two starting points:

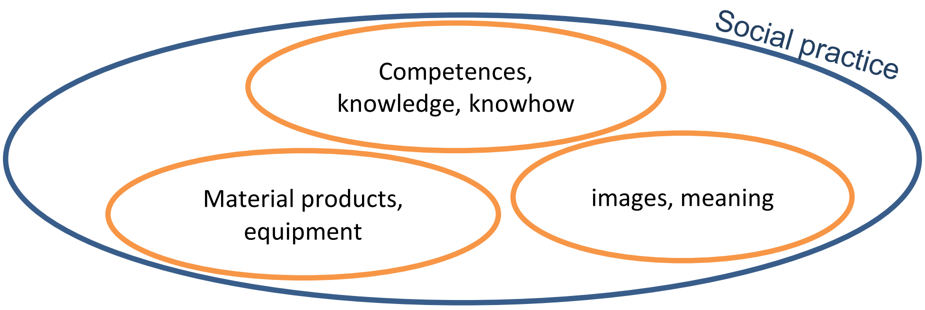
(1) Consumption is not an end in itself, but part of a social practice. Social practices we understand as a coherent set of actions and discourse around how it is in a particular context is the habit of organizing daily life. Examples of social practices are for example, eating, washing, playing, commuting, showering, sports, sleeping... Any society (such as our present one) has practices that are considered normal and set standards of living, e.g. in order to moving (by car, bicycle or public transport), eating (shopping in the supermarket, cook a recipe, have a family meal at the table), take care of yourself (daily shower, use of care products), practising a sport (with the specific equipment necessary for this to happen)... In order to understand household consumption, it is useful to understand these practices.

(2) For household consumption, we consider the direct environmental impacts (e.g. of the used energy source for heating the dwelling, or transport) and the indirect environmental impacts (of any natural resources used for the production and disposal of e.g. food, clothing, household appliances, etc.) constituting a country's main source of greenhouse gas emissions. Achieving the transition to a low-carbon society will require significant changes in social practices and related consumption patterns that determine what is considered the social norm. The concrete way in which we are housed, feed ourselves or move around must become radically less carbon-intensive. This implies a process of social change, in which the interpretation of daily social practices that are considered 'normal' today (heating of buildings by means of a central heating system fuelled by natural gas), as well as the underlying infrastructures (the pipelines, the distribution network, the way buildings are designed) and institutions (safety regulations concerning heating in buildings, our trade relations with natural gas-exporting countries, etc.) by which these practices are shaped or on which the practices depend, are undergoing a process of change.

Framing household consumption within social practices is regularly put forward to transcend the mutual incompatibilities between the two dominant paradigms of climate policy (Spaargaren 2011). According to the individualistic paradigm, climate change is a consequence of individual choices made by consumers, whose environmentally damaging behaviour will have to be addressed and adapted to avoid dangerous climate change. For example, one can choose to change one's behaviour and put on a sweater instead of turning up the heating, or to change one's purchasing behaviour and choose the more environmentally friendly version of the product. The systemic paradigm, on the other hand, assumes that steering at the macro level is more effective than steering at the micro level. From this point of view, climate policy should mainly intervene on the production side (minimum standards, regulation). Technological innovation is a crucial factor in making the production and operation of the goods that make up the current model of society climate-neutral (electrification of the vehicle fleet, switch to recyclable and renewable raw materials for the production of goods, etc.).

The social practice approach is not a combination of both insights, but a fundamentally different view of how social change processes develop. The study of the social practice in question opens a broader perspective than the study of consumption itself, and directs attention to aspects related to it: (1) What meaning do people give to social practice, which (subjective) images are associated with it? (2) What competences and know-how does practice call upon? What knowledge is needed? (3) What material necessities are needed to carry out the practice?

Figure 2. Schematic representation of what is contained by the concept of a social practice



This enriched perspective on household consumption then reveals how consumption is intertwined in the daily, normal course of life (e.g. commuting by car between home and work), which institutions support the social practice (e.g. taxation that makes the remuneration of employees in the form of a company car excessively attractive), and how infrastructures exist or emerge that support and facilitate a particular interpretation of social practice (e.g. a high density of motorways). This implies that choices about daily routine consumption are guided, making them, on the one hand, much simpler, but, on the other hand, also making a particular practice the standard, thus making it more difficult or impossible to make an alternative choice that deviates from the standard practice (lock-in) (e.g. once a decision is made to build a house and live in a remote area, in which the ease of commuting by car has played a role, it is difficult to switch to another mode of transport afterwards, even when car use becomes less attractive).

Nevertheless, social practices are constantly changing. The trajectory and the final outcome of this process of change cannot be fixed, but are constantly influenced by all actors involved in the different domains of daily life: individuals and households, producers of goods and services, which events take place, which images and discourse dominate the media and advertising, how the government intervenes in ongoing processes, which technological breakthroughs are realized, how the market functions/failures in a certain context, changing views on what is good, beautiful, tasty, hygienic or holds high status...

Individuals are neither passive subjects who undergo the lifestyle that is defined for them by social structures, nor is the model of society merely the product of all individual consumption choices. People play an important role as the practitioners of social practices, and their evaluative and creative skills determine the direction in which social practices evolve. At the same time, it is emphasized that social change embraces much more than an aggregate of individual choices: the fabric of each society, the technologies, institutions and infrastructures used, influence and order important patterns of social practices along which the bulk of everyday life takes place.

The question of how the transition to a low-carbon society can then be realized implies, from the point of view of social practices, searching how environmentally friendly interpretations of social practices can take shape, spread, and together form a generally sustainable way of life that can become the standard rather than the exception.

How these different paradigms on consumption have a direct impact on how climate policy intervention is conceived, is the topic of section 4.2.

2.3 Corridors of consumption

The low-carbon transition is caught between the social anvil and the environmental hammer. In order to better understand what is both possible and desirable, the concept of doughnut economy has been developed (Raworth 2107). It rests upon a visual framework for sustainable development and draws a space between planetary boundaries and socially acceptable boundaries of living conditions. Increasingly, researchers are making the links between planetary boundaries, ethical notions of justice, and a consideration for human wellbeing - what Gough (2017) has termed “sustainable wellbeing”. This could imply pursuing the notion of “consumption corridors” that is a minimum and maximum consumption standard, which would allow individuals to live a satisfactory life without impeding others from doing the same - across the globe and for future generations (Di Giulio and Fuchs, 2014). The “consumption corridors” concept relates to different inter-disciplinary research streams underway, bridging environmental studies and energy studies, with philosophy, sociology and political science, to name but a few.

Consumption corridors may be seen as a process that keeps human activities between a “social floor” and an “environmental ceiling” and that makes the production and consumption patterns of all humans converge towards a sustainable situation. Wealthy people should reduce the pace of their predation, while the poor should have access to a range of services that meet basic needs. The quantification of consumption corridors would draw the space of public policy possibilities and, more specifically, launch a series of debates and research in response to the urgency of the collapse of biodiversity. This perspective implies questioning a series of standards that today drive consumption upwards. Wilkinson and Pickett (2010) underline the role that inequality plays in the formation of social norms, and how these norms shape political demands for environmental protection. Conversely, more egalitarian societies, associated with higher levels of mutual trust and more civic behavior, are more likely to demand environmental policy. The social norms of the globalized upper classes, which demand more energy consumption, are pulling all social norms towards an increasingly unsustainable consumption pattern. An unequal society tends to increase the dissatisfaction of those who have less than the average amount of energy.

The cap on individual consumption is also required for environmental issues. Another way to understand this ceiling is to grasp the shrinking place of wildlife on Earth. While humans account for 0.01 percent of the planet's biomass, their activity has reduced the biomass of wild marine and terrestrial mammals by six times and the biomass of plant matter by half (Bar-On et al. 2018). It is interesting to know that livestock mass is about the double of human mass. This is a way to analyze the distribution of resources according to types of living beings. These staggering figures indicate how much space humans and their livestock leave to nonhumans and undomesticated ecosystems. Therefore, the equitable and sustainable distribution of resources is not only about humans. The injustices are much more glaring when we go beyond the anthropocentric point of view.

Gasparatos et al. (2017) reviews all observed conflicts between renewable energy and biodiversity. Each renewable energy source (solar, wind, hydro, biomass, ocean, geothermal) impacts biodiversity, although in very various ways. Biodiversity loss can be limited by adequate deployment of installations of energy captures: when we analyze the interactions between energy systems and biodiversity where it is rich, we are always dealing with specific situations that require appropriate care. It is very difficult to establish general policy recommendations other than that of reducing as much as possible the area taken up by renewable sources. (In this respect, the placement of PV panels on roofs poses very little problem to local biodiversity since the surface used was already artificialized).

The environmental ceiling can be translated into spatial boundaries, such as territories exclusively or mainly reserved for wildlife. And this is indeed what has been done since the 19th century through the constitution of nature reserves, in a distributive policy of land-use. More recently, the dimension of recognition of justice has been mobilized to make people acknowledge that many animals possess advanced forms of sensitivity or even consciousness. Animal rights have also evolved considerably, particularly with regard to their well-being. The very name of ‘livestock’ indicates how far some living beings are considered just as an accumulated quantity. And the new concept of ecocide that tries to find its way through international jurisdiction. With regard to the third principle of justice, active participation in the procedures that shape public policy, it seems to be increasingly present in works of philosophy, anthropology, and psychology, notably, which seek to show the multiple relationships between humans and nonhumans, to describe and imagine assemblages with renewed sensibilities and subjectivities (Haraway 2008). The procedural character seeks to show the multiple ways in which each living being draws resources from other living beings, most often in a cooperative manner.

There are many intersecting social and environmental issues in the transition to a low-carbon economy. Ensuring a social floor by identifying basic needs appears to be just as important as imposing an environmental cap - which at the global level mainly concerns the richest (and their imported emissions). However, it appears that it is politically and democratically preferable to start with the implementation of the minimum standards because it would make maximum standards more acceptable as everyone could see who would be the loser and the winner, supposedly that the losers of this hypothetical policy (i.e. the richest) would be the least numerous.

2.4 Why a new policy paradigm is needed

The insight that there is a close relationship between climate change and social inequality, puts new challenges to our Western welfare states. This becomes visible by the three ways in which social inequality plays an important role in the climate issue (see also Section 2.1). Firstly, there is a strong inequality in the extent to which (groups of) households contribute to the emission of greenhouse gases, and this emission of greenhouse gases is strongly related to the standard of living. Secondly, the consequences of climate disruption are more pronounced for some population groups than for others. In particular, the already more vulnerable groups are at risk of being hardest hit. Moreover, by definition, the ability of people living in poverty to protect themselves from the effects of climate change is more limited. A recent report of the European Environment Agency (EEA 2019) brings together the available empirical results for Europe. It confirms that within Europe vulnerable groups are most at risk of health damage from air pollution, noise and extreme temperatures. In particular, families at the bottom of the income scale, the elderly and children are most at risk of (irreversible) health damage or premature death due to these polluting environmental factors. During heat waves, the combination of prolonged heat (including at night) and poor air quality is particularly lethal. Half of the deaths due to the 2003 heat wave in France occurred in poorly refrigerated rest homes (Henson 2019). Accessibility to green infrastructure also plays a role: for the US, several studies found that people living in neighbourhoods with access to public green spaces (and the ecosystem services they provide, such as air purification and cooling) are less likely to die from the effects of heat than people living in neighbourhoods without these facilities. Once again, a social gradient is evident in which population groups live in which neighbourhoods: poorer groups often live in the neighbourhoods with the least access to public green spaces (Jenerette et al. 2011). Third, the financial impact of strong climate policies is uneven. Depending on the sector, the type of measure, regional characteristics as well as the functioning of labour and capital markets, climate policies can have important redistributive effects through different channels (income, labour status, land and capital ownership). There are other distributional aspects linked to the climate issue (e.g. responsibility and solidarity between generations, or distributional aspects between non-household actors, such as companies), but these are not considered here.

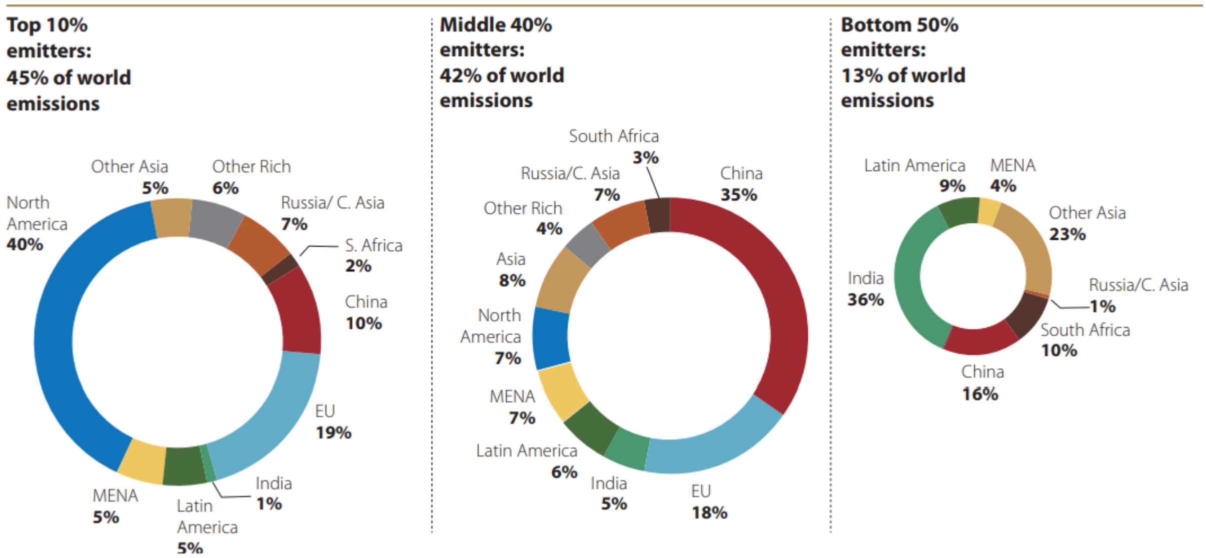
To avoid exacerbating existing inequalities or creating new ones in the transition, trade unions, social and ecological movements and academics point to the need for a socially just transition (Degryse & Pochet 2009). Increasing inequality is in itself unsustainable, but it also makes emission reduction and transition targets more difficult. The impact of the social context, dynamics and (im)balances on the success of a strong climate policy manifests itself in various ways. Firstly, from a mathematical point of view, national reduction targets as derived from the macro models are much more difficult to achieve if a significant group within the country 'lags behind' in the transition for financial reasons and is therefore unable to contribute to the intended reduction. Secondly, arguments of political feasibility play a role: social protest such as that of the 'yellow vests' indicates that public support for climate policy is also linked to its (perceived) justice. A fair distribution of the costs and benefits of the measures must therefore be proactively guaranteed in order to maximise the chances of success (see also Patterson et al. 2018). The IPCC special report on 1.5°C summarises how socially inclusive processes with participation and capacity building (social & co-learning) give more equitable outcomes thanks to the involvement of more and more diverse stakeholders, and also facilitate the (climate-needed) transformations by strengthening communities (Masson-Delmotte et al. 2018).

Climate policy will therefore not only have to intensify rapidly in order to achieve emission reduction targets, it must also explicitly ensure a socially just 'post-carbon' society and the transition towards it.

Usually the emissions of greenhouse gases and other harmful substances are reported per country or sector. Emissions are counted and monitored where they are produced (production-based perspective). However, this does not take into account that production ultimately serves consumption, which often takes place elsewhere. This consumption perspective is important for two reasons. On the one hand, it provides a better picture for cross-country comparisons: most of the figures used for this purpose are based on the production perspective, which underestimates the emissions associated with the average standard of living and lifestyle in that country. On the other hand, the distribution of greenhouse gases between households within a country also remains out of the picture. If we want to map the inequality in CO_2 emissions, the latter is precisely what we are aiming for: to describe how greenhouse gas emissions can be attributed to different households, taking into account their consumption of goods and services.

On a global scale, we see large inequalities between households. In 2015, Lucas Chancel and Thomas Piketty conducted the exercise to quantify, from a consumption perspective, the inequality in CO_2 emissions on a global scale between all households on earth. Their exercise shows that the 10% largest emitters are responsible for about 45% of global emissions (see Figure 3). These households are located on all continents of the world, and the group includes the majority of North Americans, about half of Europeans, and many smaller groups of (extremely) rich among the Chinese, Russians, Latin Americans, and other continents. Half of the world's population with the smallest carbon footprint is responsible for 13% of all emissions, and is populated by the majority of the Indian, (non-Chinese) Asian and African populations.

Figure 3. Where do the biggest and smallest polluters live? Composition of the top 10, middle 40 and lowest 50% CO_2 emitters, based on greenhouse gas emissions related to consumption.



Note: *MENA: Middle-East & Northern Africa. Source: Chancel, L. & Piketty, T. (2015). Carbon and inequality: from Kyoto to Paris. Trends in the global inequality of carbon emissions (1998-2013). Paris School of Economics.

Using this consumption perspective, we will analyse in detail how carbon emissions are distributed over Belgian households according to living standards, but also other household characteristics in section 4.2. Mapping (and continuing to monitor) the extent to which different groups in society contribute differently to greenhouse gas emissions not only helps to understand how unequally the contribution to climate change is distributed. It is also important to understand the redistributive effect of climate change. The SUSPENS project's focus will be on the first and third ways of how social inequality plays a role in the climate issue, notably the strong inequality in the extent to which (groups of) households contribute to the emission of greenhouse gases and on the distributive impact of a selection of climate policies.

3 METHODOLOGY

For our empirical analyses on household GHG emissions we have constructed a novel data base, called PEACH2AIR (see Section 3.1). The methodology for analysing the linkages between social and ecological objectives in Belgium's low carbon scenarios is described in Section 3.2.

3.1 Data, Input-Output Modelling, and pollution coefficient calculation: constructing the PEACH2AIR database

The PEACH2AIR database is combines two types of information: consumption and pollution data. The database was created by the Federal Planning Bureau of Belgium and the Herman Deleeck Centre for Social Policy – University of Antwerp and is the basis of our calculations on household GHG emissions. It concatenates a single region environmentally extended input-output model with the 2014 Belgian Household Budget Survey (HBS). The data linking method of expenditures on goods and services and their direct and indirect air pollution can be presented schematically as follows.

Box 1 Schematic structure of PEACH2AIR

Household consumption	**Air pollution data**
Household Budget Survey of 2014: representative sample of Belgian households with socio-economic characteristics of the households Expenditures on products and services purchased by households listed in the COICOP nomenclature	Coefficients of direct air pollution (CDAP) for fuels for personal motorized vehicles and domestic energy use based on the COPERT model and the Nemgian national emissions inventory resp. Coefficients of indirect air pollution (CIAP) for all COICOP products and services based on the single region environmentally extended input-output model of the Federal Planning Bureau
↓	↓
Expenditures per COICOP-item in **€**	Direct and indirect air pollution coefficient per COICOP-item in **gram/€**
↓	↓

Total air pollution (in gram) on the level of households and COICOP categories

The PEACH2AIR dataset is constructed using the following formula:

$$TAP_{h,p,c} = EXP_{h,c} \times \left(CDAP_{p,c} + CIAP_{p,c}\right) \qquad (1)$$

The formula indicates that the total air pollution (TAP) in grams of pollutant *p* by household *h* caused by consuming product *c* is equal to the sum of the coefficient of direct air pollution (CDAP) and the coefficient of indirect air pollution (CIAP) of pollutant *p* and product *c*, multiplied by the amount spent (EXP) on product *c* of the COICOP classification by household *h*. The CDAP and CIAP of a given product-pollutant combination is expressed in grams of pollution per euro spent while the expenditures are expressed in euros. We distinguish 13 pollutants (CO_2, N_2O, CH_4, NO_x, SO_x, NH_3, NMVOC, CO, $PM_{2.5}$, PM_{10}, HFCs, PFCs and SF_6) and 3 indices: Greenhouse gas index (GHG), tropospheric ozone forming potential (TOFP), and acidification (ACID).

Households pollute directly (CDAP) or indirectly (CIAP). Direct pollution refers to the pollution caused when households burn fuels directly. In our model, these are all fuels for heating or transport. The indirect pollution of a product refers to the emissions released during the full production process of goods and services. The CIAP and CDAP were calculated using a different methodology.

In this section we briefly describe the data sources. In section 3.1.1., 3.1.2., and 3.1.3. we describe the consumption, direct, and indirect air pollution data, respectively. In section 3.1.4. we describe data limitations.

3.1.1. Consumption data

The basis of our analysis is the 2014 Belgian HBS, which contains detailed information on socioeconomic characteristics and consumption patterns and levels of a representative sample of Belgian households. It consists of 6 135 households and 16 093 individuals. The HBS is a biannual survey, which builds on the Belgian Labour Force Survey (LFS)[4]. The LFS sample is a two-stage stratified sample from which the HBS is drawn in the third stage. Sampling variables were taken into account throughout the analysis for this report. The HBS micro-data was provided by STATBEL, Belgium's statistical office.

During the HBS, each participating household was provided a logbook which they filled out for the duration of a month. In this logbook, they recorded all their expenditures (type of expenditure, price, quantity, unit of measurement, private part of purchase, place of purchase). At the end of the month, an interviewer visited the household, and recorded answers to a questionnaire that collects information about the composition and socioeconomic characteristics of the household (income, age, region, education, etc.), details about the dwelling of the household (year of building, heating type, etc.), periodical expenses (e.g. television subscription) and possession of large devices (e.g. car, laptop, washing machine). There are also questions about the purchase of durable goods during the previous four months.

The reference period of our research is the year 2014: expenditures and emissions of households are expressed for the whole of the year 2014. The registration period for expenses in the logbook is one month (and different households fill out the logbook in different months). These expenditures were then annualized for the year 2014.

In the HBS, expenditures are categorized according to Classification Of Individual COnsumption by Purpose (COICOP). The COICOP classification is the international reference classification for household expenditures, maintained by the United Nations Department of Economic and Social Affairs. It consists of 12 1st level groups, which is broken down further into more and more detailed 2nd, 3rd, and 4th level subgroups. For Belgium, there is a 5th level, which results in a total of 1 154 consumption categories. To present the results, we created the following 5 big consumption categories: Food and drinks,

[4] Before 2012 the survey was annual and separate from the LFS.

Energy and Housing, Transport, Goods, Services (see Cooreman et al. (2019) for further details).

We carried out some data manipulation in the HBS to make it better suited for our analysis. There are two issues that pose a problem to accurately account for the emissions of each household. Firstly, non-frequent expenditures, and secondly the underreporting of fuel expenses of company car-using households. In the next two paragraphs, we briefly describe how we treated these issues. The reader can find further details in the annexes of the report by Cooreman et al. (2019).

- Non-frequent expenditures, such as expenditures on durable goods or holidays, are problematic, because we observe large amount of expenditures (and subsequent emissions) on these goods and services for a small number of households, and zero expenses for the rest of the households. However, the rest of the households also spend on and use these goods and services, but at times that fall outside the timespan of the survey. There is a discrepancy between the lifetime (or purchase frequency) of these goods and services and the timeframe of the survey (one month for the logbook and a four-month timespan before the questionnaire regarding questions about durable purchases). We treated this problem by creating household clusters and distributing non-frequent expenditures among the households within each cluster.
- Company cars are a type of benefit in kind provided by the employer to the employee. Both commuting-related and private fuel expenses of the employee are paid partly or totally by the employer. Consequently, company car-using households report less expenses on fuel in the HBS than the other households. However, this does not mean that company car-using households travel and emit less than the other households. Given that (1) in this report we aim to analyse the distribution of emissions among households, and that (2) company car-using households are positioned in the middle and upper part of the income distribution, leaving this topic unaddressed would result in distorted results. We treated this issue by imputing fuel expenses for company car-using households based on the observed fuel expenses of the rest of the households.

3.1.2. Coefficients of direct air pollution

The direct pollution coefficient of pollutant *p* created by consuming 1 euro of a certain fuel *c* used for transport, is the result of the formula below. A detailed description of all components of these formulas can be found in published working paper.

$$CDAP_{p,c} = \frac{Total\ direct\ pollution_{p,c}\ (g)}{Total\ consumption_c\ (g)\ *\ specific\ volume_c\ \ (l/g) *\ \ price_c\ (euro/l)} \qquad (2)$$

$$where\ c\ \in\ \{diesel, gasoline, LPG, two - stroke\ oil, other\ fuels\ \}$$

Data on the total direct pollution and total consumption of fuels used for transport was sourced from the COPERT model. COPERT is a European road transport emission inventory model. We used total pollution and consumption data from COPERT for 2014 based on the 2019 submission and selected only vehicle types typically used by consumers such as passenger cars. The specific volume of the fuels was found in the Energy Statistics Manual of the International Energy Agency. The price per litre is based on disaggregated FPB data used to calculate the consumer price index.

To calculate the coefficients of direct air pollution of fuels used for domestic energy use, we used two different formulas, because the price of liquid fuels is expressed per litre and had to be transformed.

$$CDAP_{p,c} = \frac{Emission\ factor_{p,c} * Energy\ conversion\ factor_c * \frac{Net\ Calorific\ Value}{Gross\ Calorific\ Value}_c}{Price_{(h),c}}$$

$$if\ c \in \left\{ \begin{matrix} natural\ gas, natural\ gas\ second\ home, \\ butane, propane, coal, firewood, other\ solid\ fuels \end{matrix} \right\} \quad (3)$$

$$CDAP_{p,c} = \frac{Emission\ factor_{p,c} * Energy\ conversion\ factor_c * \frac{Net\ Calorific\ Value}{Gross\ Calorific\ Value}_c}{specific\ volume_c * Price_{(h),c}}$$

$$if\ c \in \{fuel\ oil, other\ liquid\ fuels\}$$

We used emission factors, which are expressed in gram of pollution per Joule, from the Belgian national emissions inventory of 2017 for the year 2014 and emission factor data of the Flemish and Walloon region. The energy conversion factors and the specific volume of certain fuels can be found in the Energy Statistics Manual. We based the values of the share of net calorific value in the gross calorific value of a fuel on the IPCC background paper titled ‘Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories’ (IPCC, 2001).

For natural gas and fuel oil, the price per unit of fuel depends on the amount a household bought, as indicated by the (h) suffix. This is mainly due to different levels of taxes (natural gas) or because the price per unit is significantly lower for large orders (fuel oil). For all other fuels and other products, we assume uniform prices.

3.1.3. Coefficients of indirect air pollution

The majority of household-level air pollution is indirect and is embodied in the supply chain of goods and services purchased by households. Indirect emissions were calculated using an environmentally extended single-region input-output model of the Federal Planning Bureau. The methodology is discussed in detail in Frère et al., 2018. In our database, each household is assigned the amount of emissions related to their reported consumption.

Input-output (IO) analysis is a methodology that uses industry-level data to map supply chains in the economy. When extended with industry-level air pollution data, it becomes possible to quantify how much air pollution is embedded in the production process of goods and services on the industry level. These industry-level data (according to the Belgian SUT classification) were connected with the COICOP classification of the HBS in order to quantify the air pollution embedded in the consumption of goods and services by the households. Further details on the SUT-COICOP linkage can be found in Frère, Vandille and Wolff (2018).

We do take account of emissions related to imported goods, albeit assuming their production technology is the same as the production technology of the same product produced in Belgium. This type of input-output model is called a single region input-output model (as opposed to multi-region input-output models, which use supply and use tables for the IO model from several countries).

3.1.4. Data limitations

Our model's data are subject to different limitations. First, as mentioned, our input-output model belongs to the single-region category, which comes with an important disadvantage. In contrast to multi-regional models, single-region models assume that the production technology in foreign countries is the same as in Belgium. When assigning environmental coefficients to goods such as apples or solar panels, we assume the production technology is identical to the one used in Belgium. In other words, we use the mix of inputs (for raw materials, transport and production) that is used in the Belgian industry for this product. This implies that we make abstraction of the fact that products that were purchased in Belgium but produced in another country (e.g. foreign steel) were probably produced with different material and energy inputs than products produced in Belgium. The main advantage of using the single-region input-output model is that it is the most detailed input-output model of Belgium currently available. The SUT classification consists of 354 industries, while (to the best of our knowledge) the most detailed MRIO model – Exiobase – which uses data of 2007 consists of 162 industries.

Second, we relate emissions to each euro spent on the consumption categories in the HBS. However, in reality, emissions occur during the production of units of goods for many product categories. As our pollution coefficients are on a gram of pollution per euro basis, we have to assume a sufficient homogeneity of the price of the goods belonging to the same category (e.g. peaches or cars).

Third, there is a risk that some consumption categories are underreported in the household budget survey. People might be inclined to report lower expenditures than in reality for products with stigma such as drugs, alcohol or tobacco (and possibly other consumption categories). However, given that comparable external statistics are difficult to obtain or construct, it is hard to assess the bias that results from this. As the categories we assume to be most prone to underreporting are not the ones generating big environmental impacts, we believe the bias from underreporting has a rather minimal impact upon our overall results in terms of emissions.

Fourth, non-frequent purchases by households as reported in the HBS as well as the underreporting of fuel expenses by households using a company car pose a problem for accurately estimating the level and distribution of household emissions. The details of how we treated these problems can be found in the annexes of working paper by Cooreman et al. (2019). Another HBS-related issue is the pollution caused by the construction of houses and entire home renovations. These are not included in our model, because these expenditures happen too infrequently to reliably appear in the HBS. Moreover, the data on the stock of houses in HBS is not detailed enough to be able to impute a certain amount of pollution for housing. The consequence of this is that expenditures related to rent or mortgages are not considered in PEACH2AIR and consequently no pollution is attributed to these expenditures.

Fifth, the expenses in HBS related to domestic energy use rely on a sizeable amount of imputation. As is noted in the methodological note of HBS 2014, the respondents could use so-called combined invoices for which there is only one amount for two or more types of energy expenditures. There are, for example, 4 522 mixed invoices for electricity and natural gas on a total of 6 135 households. A regression predicting the expenditure on electricity based on household size, region, possession of a washing machine and possession of solar panels was used to split these mixed invoices. For these 4 522 cases, the residual amount was attributed to natural gas. By consequence, all potential leftover variation in the use of electricity between households will appear in the expenditures on natural gas. A specific analysis of the energy-related expenditures or pollution should therefore be interpreted with care[5].

Finally, there are also emissions related to (voluntary or involuntary) consumption of publicly provided services, such as the education, health, social services and urban planning. Although the indirect pollution coefficients take the pollution by government individual consumption into account for certain consumption types (education, health and social services), such pollution will only appear in our model if these expenditures are represented in the HBS. This might in our methodology bias the attribution of pollution caused by the consumption of public goods to the households.

5 See the methodological note on HBS 2014 for a full overview of all imputations of energy-related expenditures.

3.2 A case-study approach: scenarios for a low carbon Belgium

We have studied the case of the strategy towards a low-carbon Belgium. More specifically, we have carried out an analysis of existing institutional low-carbon scenarios exercises. These scenarios are artifacts situated at the interface between science and policy, and taken as an entry point for exploring the linkages between social and ecological objectives into low-carbon transition processes. Our analysis develops on a **multiple case study analyzing if and how various energy foresight studies carried out for Belgium address justice issues**. The criteria used for selecting the cases studies are the following:

(1) The study corresponds to the definition of foresight developed in Fransolet (2019) – i.e.: "*a policy-oriented approach assuming that the future is multiple, uncertain and potentially radically different from the present, and aiming at envisioning and exploring in a systemic and holistic way alternative images of the future*" (Fransolet 2019, p.29).

(2) The study explores at least one low-carbon scenario. Such scenario results in a low-carbon regime in 2050. The low-carbon regime can be described quantitatively (i.e.: reduction of GHG emissions of 80-96%) or qualitatively.

(3) The geographical scope of the study covers all or part of Belgium, without exceeding the national territory.

(4) The study has been commissioned by a public actor.

(5) For practical reason, the report of the study is written in French or English.

Seven energy foresight studies meeting these criteria were found. The studies analyzed are the following: "Towards a low-carbon Wallonia in 2050" (CLIMACT 2012), "Scenarios for a low-carbon Belgium by 2050" (CLIMACT and VITO 2013), "Macroeconomic impacts of the low-carbon transition in Belgium" (CLIMACT and VITO 2013), "Low-carbon scenarios for 2050 for the Brussels-Capital Region" (CLIMACT 2017), "Towards 100% renewable energy in Belgium by 2050" (VITO, ICEDD, and Bureau fédéral du Plan 2012), "Prospective study: Energy transition" (CLIMACT et al. 2015), and "What energy networks for Wallonia in the 2030 and 2050 horizons?" (ICEDD et al. 2018). Four of them are limited to the regional territory (i.e.: CLIMACT 2012; CLIMACT 2017; CLIMACT et al. 2015; ICEDD et al. 2018) and the other three consider the whole country (i.e.: CLIMACT and VITO 2013; CLIMACT and VITO 2013; VITO, ICEDD, and Bureau fédéral du Plan 2012). Besides the geographical scope, the chosen studies differ *inter alia* in terms of clients, contractors, year of publication (i.e.: between 2012 and 2018), normative and material scopes (i.e.: from the energy system to the entire socio-technical system), approach (i.e.: forecasting or backcasting), methodology (i.e.: bottom-up modelling, top-down modelling or qualitative methodology inspired by the work of the French *prospectivists* Hugues de Jouvenel and Michel Godet), but also regarding the level of participation and actors involved (i.e.: from expert-based analysis to participative exercises). The table below summarizes the main features of the studies analyzed [Table 2].

The selected energy foresight studies were examined through a framework allowing to assess the way they address justice issues. With that aim in mind, we considered the **three dimensions of justice (i.e.: distributional, recognition and procedural)** and the **associated capabilities** presented in the working paper (Fransolet 2019). For each capability, we defined a number of **evaluative and normative questions**. For each question, the material (people, communities or non-human species and ecosystems), spatial (local, national or international) and temporal (short, medium or long term) scope can be specified. More specifically, we reviewed the seven energy foresight studies presented above, attempting to determine if and how they deal with the different questions. Note that several studies are based on quantitative models. For practical reasons, we did not analyze the simulation tools *per se*, but the papers presenting the models in question

4 SCIENTIFIC RESULTS

This section summarizes the scientific results for the different objectives of the SUSPENS-project, along the structure of the objectives outlined in the introduction. While section 4.1 (Assessing the Belgian governance context against principles of justice) and 4.2 (Social practice perspective to household consumption: implications for climate policy and its distributional impacts) elaborate the theoretical underpinning of the SUSPENS project, section 4.3 (How are GHG emissions distributed across the Belgian population?) and 4.4 (Which household characteristics are associated with the level of GHG emissions of households?) outline the key findings from the PEACH2AIR dataset that is at the heart of the SUSPENS project and was discussed methodologically in Section 3.1. Applying our framework to concrete policy domains, we analyse the social and ecological outcomes of case studies in the domain of housing (section 4.5. Housing: from pilot projects to large-scale solutions?), food (section 4.6. Sustainable diet patterns: modelling possibilities with PEACH2AIR) and carbon taxation (section 4.7. Exploring the heterogeneous effects of a carbon tax and dividend scheme in Belgium).

4.1 Justice

The review of the energy foresight studies carried out for Belgium reveals that justice issues are hardly addressed in the analyses of low-carbon transition pathways. The potential conflicts and synergies between low-carbon strategies and social justice objectives are actually not taken into consideration, or only in a very limited way, in the scenario analyses reviewed. In the cases where these interactions are considered, we note that the analysis is often limited to distributive justice issues. Taking a closer look at the different forms of justice, we indeed observe that recognition and procedural justice are missing in almost all the analysis. The limits of low-carbon scenarios in addressing justice issues do of course not apply to the same extent to the different case studies. More specifically, the scenarios analyses based on more systemic approaches, such as the “Energy transition” study and, to a lesser extent, the “Energy networks” study, which develop on qualitative methodologies inspired by the work of the French prospectivists Hugues de Jouvenel and Michel Godet, take a more detailed look at the justice issues. Fransolet (2019) presents in more detail the results of the review of the low-carbon scenarios carried out for Belgium by distinguishing three types of scenario approaches: techno-economic, economic and systemic analyses. To understand the specific features of each case study, the reader is invited to consult the summary table in the working paper (Table 6 in Fransolet 2019).

4.2 Social practice perspective to household consumption: implications for climate policy and its distributional impacts

The different paradigms on consumption (individualistic or systemic) have a direct impact on how policy intervention is conceived.

An individualistic framework assumes that the difference in the fight against climate change is primarily made by the choices of individual consumers. The role of the policymaker is then to entice consumers to make more environmentally friendly choices and to adapt their behaviour. This leads to policy measures such as pricing, persuasion, giving advice. Shove (2010) summarised this view of social change as the ABC paradigm, which focuses primarily on changing attitudes (A), as a driver for behaviour (B) in which individuals choose (C) to act in a more environmentally friendly way. The reasoning implies that if enough individuals would choose to behave in a more environmentally friendly way in the choices they make regarding food, mobility or housing, climate change can be averted. This line of reasoning places the responsibility for averting a dangerous degree of climate change on the citizen-consumer. Policies based on this line of thought try to respond to the motivations for the choices people make (with financial incentives, advice, info campaigns or 'nudging'), to get more people to the intended behaviour (commuting to work by bike, not leaving unnecessary lights on, putting on a thick sweater and heating a degree lower, consuming food with a lower CO_2 footprint, travelling less by plane, buying recycled paper, ...). The central problem with an ABC perspective on policy intervention is that climate change is framed as a problem of individual behaviour, and therefore other - equally necessary - ways of tackling climate change are left out of sight (e.g. possible interventions that precede behavioural change).

Policy intervention from a systemic point of view focuses mainly on stimulating technological innovation. While efficiency is promoted (insulating houses, increasing recycling rates), green technology is subsidised (solar panels, biofuels) or higher efficiency standards are set (e.g. on household appliances, new construction, or cars), the standard way of life itself is not questioned. Current conventions remain valid, technological innovation helps to maintain the status quo, with a carbon neutral form of the standard way of life as the ultimate goal. However, the assumptions made in a scenario where this would succeed remain controversial (e.g. the resource intensity of our current consumption should decrease drastically and at a rapid pace, while the empirical evidence to date indicates rather the opposite, e.g. Druckman & Jackson 2009).

Approaching it from a social practice perspective, the focus of policy intervention will be on how the different actors, including citizens and government, help to shape the fabric of daily life. The way we feed ourselves, how we move around, how and what energy we consume in the home, is largely embedded in social, institutional and infrastructural tissues: how roads are constructed, how spatial planning spreads functions such as housing, agriculture and greenery, how food distribution systems are organised, how housing options are structured, what time allocation between paid work, family, and leisure is the standard. In a framework of social practice, the aim of climate policy is, in other words, to help transform structures and institutions that manage everyday life, thus making it possible for a sustainable way of life to become the norm.

Other policy areas have long been based on this approach. There is broad recognition in health policy of how a structured public health system makes public health problems more manageable and affordable. Research is also making it increasingly clear that a policy that only focuses on individual (eating) behavioural change has little chance of succeeding in solving a problem such as obesity. Unhealthy living environments contribute to obesity (Townshend & Lake 2008). To really counteract this problem, more systemic levels should also be addressed, such as access to healthy food, and prevailing time and mobility patterns (Dixon and Broom 2007, quoted in Shove 2010).

Shove & Walker (2010) plea for a climate policy that is both more modest and more ambitious. More modest in the recognition that government policy will never form the societal transition in a vacuum: civil society, producers, citizens, must be "with" in order to (be able to) fulfil their part of the transition story. The ambition to steer this change in a targeted way is, in a sense, an illusion, since the impact of a measure always depends on how the other actors involved interact with it. Rip (2006) calls this a co-evolutionary view of the change process, and emphasizes that interventions are always part of the change process themselves, rather than one actor directing the change process. But it is also more ambitious, in the sense that the scope of policy intervention is defined much more broadly. Increased insight into the dynamics between household consumption and the social structures within which daily life takes place also means recognition of how structures influenced by government, such as taxation, the democratic system and spatial planning, help to determine the patterns of daily life and thus also the environmental impact of routine household consumption.

Environment-related intervention in household consumption is a sensitive area. One quickly discovers paternalistic motives in policies that want to intervene on how people spend their income. There is also no guaranteed recipe for success. The usual policy instruments such as information campaigns or behavioural change taxes are successful in some contexts and fail in others. But there is also often reluctance on the part of policymakers for social reasons. Where environmentally damaging consumption would be discouraged through taxation, the distributional impact of such a measure often follows a regressive pattern (Büchs et al, 2011). For example, although low-income households consume less in nominal terms (as we document for Belgium in section 4.3), a proportional carbon tax would still put a heavier burden on lower-income households than on higher-income households. Because these are often basic needs, poorer households typically spend a higher percentage of their income on the most CO_2-intensive consumption such as household energy consumption, food, and, to a lesser extent, transport. As these goods become more expensive, they would therefore be relatively more affected.

At the same time, a pro-rich distribution pattern also applies in our country for a number of important subsidies and tax advantages for environmentally friendly investments by households (insulation, solar panels, advantages for new low energy houses). The possibility to make the investment is often reserved for households that own a house and are sufficiently mediated to finance the initial cost. These observations could lead to the conclusion that there is a kind of trade-off between social and environmental objectives in our current welfare state (Gough 2013).

However, the question of the social distributive effects of the transition to a low-carbon society can be opened up in different ways. In addition to fruitful avenues of research such as how distributional effects go beyond financial ones, the SUSPENS research project argues that social practices (and their evolutions) in themselves have a social gradient. Income is a determining factor, both in the accessibility of some practices (flight holidays, car mobility), and in the way families fill in social practices (patterns of energy consumption in a cramped rental apartment versus in a rural villa). When studying how social practices with a high CO_2 impact (could) evolve in the transition to a low carbon society, it is relevant to include their social variety in the analysis.

Also emerging practices that explicitly enroll in a sustainability discourse are not socially neutral in their effects. While some explicitly focus on exploiting inherent synergies between social and environmental objectives (especially in the area of housing, where housing quality and energy intensity can be addressed together), the distribution analysis of social practices such as group purchases from local food producers (e.g. food teams), reducing weekly working hours, or car sharing, is not a priori clear. These measures are often mentioned when trying to outline the possible contours of a sustainable way of living and consuming in the future.

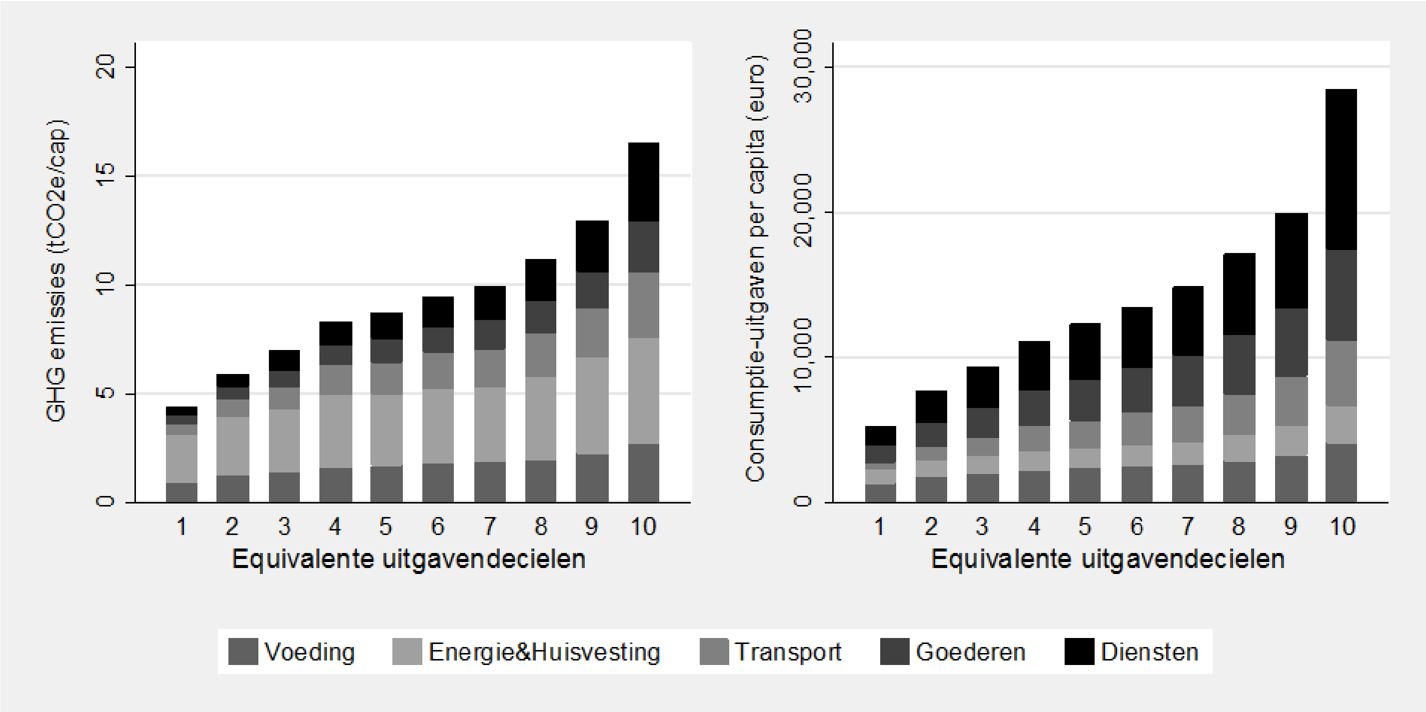
The social practice approach provides a framework to investigate how lifestyles and associated consumption patterns differ across the social strata of the population. An integrative social and ecological perspective based on social practices can reveal how social and ecological configurations are combined in certain lifestyles. It can also provide insight into which types of policies aimed at influencing the social transition process towards a low-carbon society succeed in reconciling social and environmental objectives of the welfare state.

4.3 How are GHG emissions distributed across households?

Available research for 'western' countries shows that the household's standard of living (measured via disposable income or total expenditure) has the strongest influence on its carbon footprint. Since CO_2 emissions are derived from consumption expenditure and that expenditure increases significantly as the family becomes richer, this is on the one hand a logical outcome. On the other hand, the impact of the standard of living overshadows other family characteristics that also have an impact, such as housing location (urban/rural), size and typology of the dwelling, age, level of education, or economic status. Household size was also found to be an important determinant: larger households emit more in absolute terms, but on a per capita basis emissions decrease as the family has more members. This trend has to do with the economies of scale of many types of consumption: an additional person in the household leads not to proportionally, but only marginally more heating, transport, or household goods purchased.

Our analysis for Belgian households confirms these patterns: average greenhouse gas emissions per capita are strongly driven by the standard of living. Figure 4 shows how consumption-related emissions for Belgian households in 2014, expressed in tonnes of CO_2 equivalent per person per year, are on average about four times higher in the richest decile than in the poorest (when we order households according to their total expenditure).

Figure 4. The distribution of per capita emissions (left) and per capita consumption expenditure (right) over equivalent expenditure deciles for persons in a Belgian household, 2014.



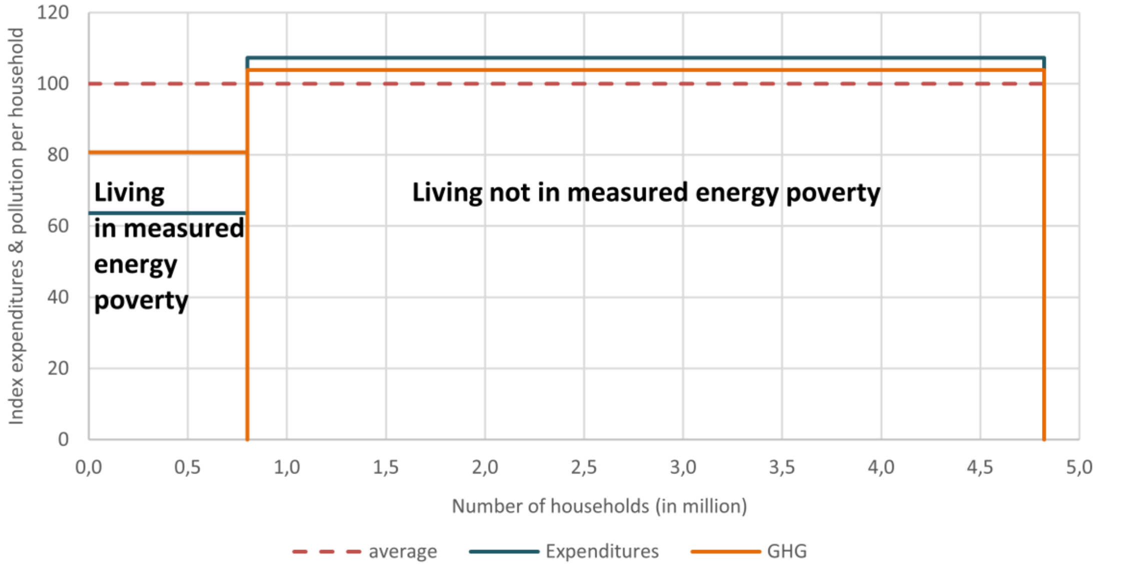
Source: Lévay, P. et al. (2019). De sociale verdeling van broeikasgassen in België. CSB-bericht 2019/07. Antwerpen: CSB. Op basis van de PEACH2AIR database.

However, the relationship between standard of living and consumption-related CO_2 emissions differs widely between different consumption categories. Emissions related to food or housing (typical basic needs) are fairly evenly distributed: in nominal terms, emissions increase slightly on average depending on the households that are higher up in the distribution, but not in proportion to the existing income and expenditure differences. Emissions from transport, goods and services increase much more with a rising standard of living. While at the lower decile this causes only a small fraction of emissions, at the highest decile these three categories account for more than half of emissions.

The GHG-emissions associated with the consumption of households can also be described taking into account other household characteristics. Here three examples are presented.

1. We calculated which households live in measured energy poverty according to a methodology by Coene and Delbeke (2016)[6]. The next graph shows that households living in energy poverty pollute less than the average household but have a high pollution intensity. Note, however, that if the graph would be on a per capita base, pollution per capita of household in energy poverty would be 15% above the average per capita pollution while expenditures would be at 90% of the expenditure per capita. This indicates that households living in energy poverty are smaller than average.

Figure 5. Expenditures and greenhouse gas emissions by households living in measured energy poverty or not, expressed as a % of the average pollution and expenditure per household

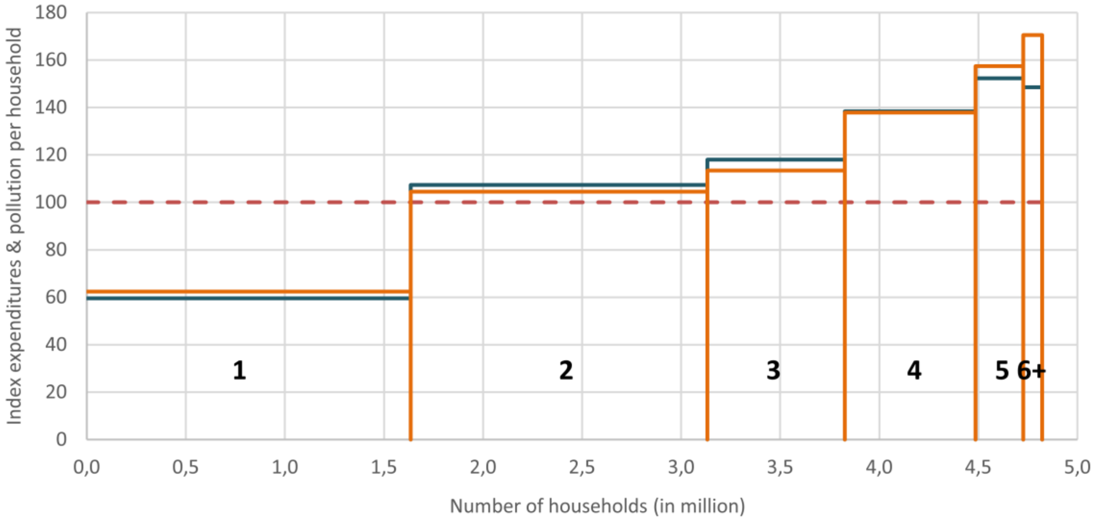


Source: Cooreman et al. (2019) Analysis of the air pollution associated with household consumption in Belgium in 2014: the case of greenhouse gas emissions, FPB Working paper 8-19. Brussels: Federal Planning Bureau.

[6] Contrary to these authors, we used HBS data in the PEACH2AIR dataset rather than SILC data. A household is considered to live in measured energy poverty if the ratio of energy expenses to income excluding costs related to the dwelling is higher than two times the mean ratio of the two. These households have to be in the first five (equivalised) income deciles too. Using HBS data, 12.8 percent of the population lives in measured energy poverty compared to 14.6% measured using SILC data by Coene and Delbeke.

2. Total pollution increases less than proportionally with household size. This effect, which can be interpreted as an economies of scale effect, appears both on the expenditure as on the total pollution side. Pollution intensity is higher than average for one person households and very large households. Two and three person households have a lower than average pollution intensity.

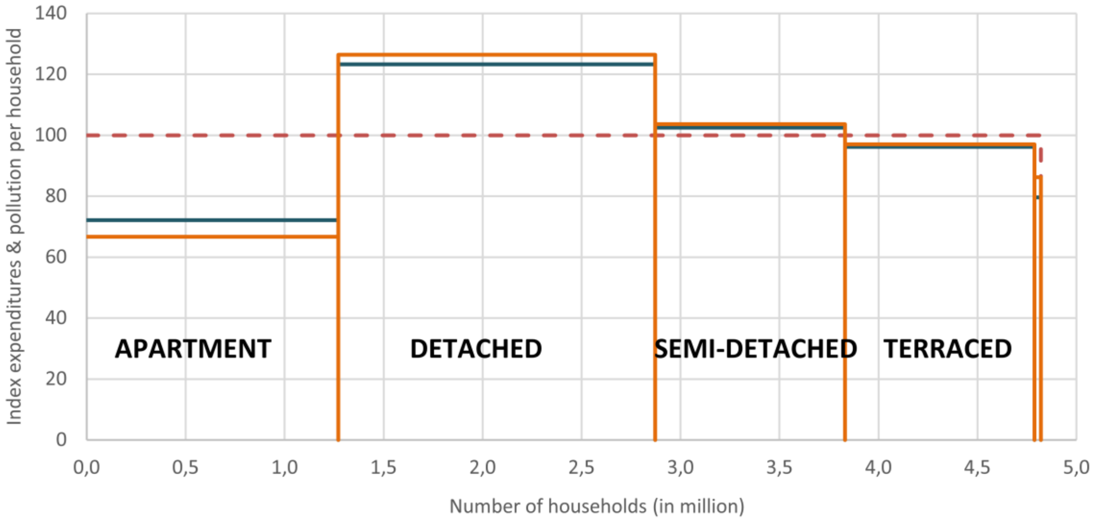
Figure 6. Expenditures and greenhouse gas emissions by households per household size, expressed as a % of the average pollution and expenditure per household



Source: Cooreman et al. (2019) Analysis of the air pollution associated with household consumption in Belgium in 2014: the case of greenhouse gas emissions, FPB Working paper 8-19. Brussels: Federal Planning Bureau.

3. The type of housing affects the level of pollution and the pollution intensity of a household. Households living in a detached house emit 26% more greenhouse gases than average, which is more than any other type of house. Detached houses also have a higher than average pollution intensity. The denser a type of housing (semi-detached, terraced, apartment), the less a household pollutes. Households living in an apartment not only pollute the least, their total pollution is a little more than half of that of a detached house, but they also have the lowest pollution intensity. One could argue that this difference in pollution per household is due to a higher average household size living in detached houses. This is, however, only partially true. Even pollution per capita is more than 10% higher than average for individuals living in a detached house and pollution intensity is still higher than average.

Figure 7. Expenditures and greenhouse gas emissions by households per type of housing, expressed as a % of the average pollution and expenditure per household.



Source: Cooreman et al. (2019) Analysis of the air pollution associated with household consumption in Belgium in 2014: the case of greenhouse gas emissions, FPB Working paper 8-19. Brussels: Federal Planning Bureau.

Category-specific analyses indicate that food, fuel used for transport and domestic energy use, account for more than 60% of greenhouse gas emissions while they represent less than 30% of the total expenditure. Not surprisingly, these are categories with a high pollution intensity. We also observe that while pollution increases with income, pollution intensity (gram of pollution per euro spent) decreases as income increases. In other words, the higher the income, the lower the share of emission-intensive consumption, such as heating. In general, different household characteristics such as region, type of heating, type of house or household size tend to be associated with different levels of pollution. These characteristics are, however, interdependent, as will be explained in the following section.

4.4 Which household characteristics are associated with the level of GHG emissions of households?

Using the multiple regression (Table I) and the dominance analyses (Table II) we have estimated the household determinants both for total emissions, and separately for emissions by expenditure category. The R-squared of the regression models ranges between 0.62 for the consumption of goods, and 0.26 for domestic energy consumption for housing, and is equal to 0.58 for total emissions.

Table I. Results of multiple regression analyses

	(1) Ln(GHG_total)	(2) ln(GHG_Food)	(3) ln(GHG_Energy_housing)	(4) ln(GHG_Transport)	(5) ln(GHG_Goods)	(6) ln(GHG_Services)
Income	0.323***	0.235***	0.114***	0.589***	0.693***	0.582***
	(0.019)	(0.019)	(0.025)	(0.040)	(0.030)	(0.046)
Number of adults						
1	0.000	0.000	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)	(.)	(.)
2	0.199***	0.437***	0.103***	0.360***	0.203***	0.175***
	(0.017)	(0.019)	(0.025)	(0.036)	(0.023)	(0.049)
3	0.264***	0.573***	0.149***	0.300***	0.126***	0.236***
	(0.023)	(0.027)	(0.032)	(0.065)	(0.030)	(0.062)
>=4	0.354***	0.738***	0.192***	0.284***	0.140***	0.387***
	(0.029)	(0.026)	(0.043)	(0.056)	(0.032)	(0.086)
Number of children						
0	0.000	0.000	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)	(.)	(.)
1	0.095***	0.123***	0.070**	-0.038	-0.018	0.269***
	(0.015)	(0.023)	(0.024)	(0.040)	(0.018)	(0.039)
2	0.122***	0.225***	-0.009	-0.088*	-0.066**	0.444***
	(0.015)	(0.022)	(0.025)	(0.039)	(0.020)	(0.050)
3	0.190***	0.316***	0.052	-0.105	-0.084*	0.636***
	(0.034)	(0.032)	(0.054)	(0.075)	(0.033)	(0.087)
>=4	0.292***	0.428***	0.122	0.093	0.051	0.730***
	(0.055)	(0.069)	(0.118)	(0.151)	(0.053)	(0.185)
Age of reference person	0.005***	0.010***	0.005***	-0.001	0.001	0.008***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.002)
Prof.stat.refpers.						
working	0.000	0.000	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)	(.)	(.)
unemployed	-0.085**	-0.084	0.018	-0.404***	-0.198***	-0.246***
	(0.030)	(0.045)	(0.048)	(0.072)	(0.040)	(0.069)
student	-0.067	-0.120	-0.034	-0.360**	-0.104	0.090
	(0.098)	(0.096)	(0.187)	(0.136)	(0.115)	(0.178)
homemaker	-0.046	-0.127*	0.051	-0.235	-0.096	-0.199
	(0.064)	(0.061)	(0.133)	(0.204)	(0.061)	(0.179)
incapacitated	-0.046	0.009	0.047	-0.406***	-0.067	-0.062
	(0.034)	(0.037)	(0.059)	(0.074)	(0.039)	(0.075)
pension	-0.049*	-0.030	-0.007	-0.149**	0.003	-0.053
	(0.025)	(0.024)	(0.037)	(0.056)	(0.033)	(0.060)
Education						
primary or less	0.000	0.000	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)	(.)	(.)
lower secondary	0.025	-0.023	0.060	0.055	0.017	0.083
	(0.031)	(0.044)	(0.065)	(0.091)	(0.045)	(0.074)
upper secondary	0.092**	0.044	0.074	0.262**	0.110**	0.301***
	(0.030)	(0.040)	(0.051)	(0.081)	(0.040)	(0.077)
tertiary	0.173***	0.147***	0.092	0.323***	0.236***	0.515***
	(0.032)	(0.040)	(0.055)	(0.077)	(0.040)	(0.078)
Region						

	(1) Ln(GHG_total)	(2) ln(GHG_Food)	(3) ln(GHG_Energy_housing)	(4) ln(GHG_Transport)	(5) ln(GHG_Goods)	(6) ln(GHG_Services)
BXL	0.000	0.000	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)	(.)	(.)
VL	0.019	-0.034	-0.021	0.170*	0.035	0.080
	(0.028)	(0.025)	(0.038)	(0.073)	(0.022)	(0.061)
WA	0.100***	-0.016	0.200***	0.314***	0.017	-0.108
	(0.029)	(0.024)	(0.038)	(0.075)	(0.023)	(0.063)
Tenure status						
Owner	0.000	0.000	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)	(.)	(.)
Tenant	-0.109***	-0.050*	-0.060*	-0.242***	-0.113***	-0.315***
	(0.016)	(0.024)	(0.026)	(0.045)	(0.018)	(0.043)
Number of rooms						
1	0.000	0.000	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)	(.)	(.)
2	0.185***	0.168*	0.119	0.184	0.126	0.348***
	(0.052)	(0.065)	(0.084)	(0.156)	(0.066)	(0.091)
3	0.248***	0.095	0.218*	0.342*	0.177*	0.462***
	(0.049)	(0.064)	(0.087)	(0.154)	(0.071)	(0.092)
4	0.323***	0.139*	0.330***	0.473**	0.186**	0.465***
	(0.047)	(0.068)	(0.083)	(0.153)	(0.071)	(0.092)
5	0.356***	0.196**	0.405***	0.473**	0.203**	0.466***
	(0.048)	(0.069)	(0.088)	(0.158)	(0.071)	(0.092)
>=6	0.398***	0.230***	0.471***	0.429**	0.236***	0.516***
	(0.049)	(0.067)	(0.088)	(0.165)	(0.069)	(0.097)
House type						
Detached	0.000	0.000	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)	(.)	(.)
Semi-detached	-0.083***	-0.008	-0.134***	-0.175***	-0.012	-0.010
	(0.012)	(0.016)	(0.021)	(0.030)	(0.020)	(0.030)
Apartment	-0.162***	-0.061*	-0.371***	-0.254***	-0.066*	0.137**
	(0.019)	(0.025)	(0.035)	(0.050)	(0.028)	(0.052)
Other	-0.015	-0.046	-0.118	-0.155	0.156	0.170
	(0.082)	(0.135)	(0.171)	(0.188)	(0.126)	(0.191)
Constant	-1.342***	-2.389***	-0.171	-6.080***	-7.021***	-6.931***
	(0.218)	(0.221)	(0.298)	(0.470)	(0.295)	(0.483)
Observations	6124	6124	6124	6124	6124	6124
R^2	0.581	0.486	0.265	0.411	0.620	0.354

Note: Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Income is the most important determinant of the total HCF, accounting for 28 percent of the explained variance in total HCF (see Table II). The coefficient of the income variable is 0.32, i.e. a one percent increase in household income is associated with a 0.32 percent increase in household GHG emissions, holding other factors constant (see Table I). This elasticity is lower than in the reduced-form log-log model, indicating that part of the bivariate association of emissions and income runs through other factors that are associated with income. Both the importance of income in the dominance analysis and the income elasticity of the HCFs vary greatly across the five categories. While income is the most important variable in the 'Goods' and 'Services' models, accounting for 43.3 and 32.2 percent of the explained variance, respectively, its importance is much less in the 'Food' and 'Energy and housing' models. Income elasticities of emissions in the 'Energy and housing' and 'Food' models are also lower than in the other models, being 0.11 and 0.24 percent, respectively, ceteris paribus. These two categories mainly incorporate goods and services that satisfy basic needs. As a result, it can be expected that low income households spend a proportionally higher share of their income on these categories, and high-income households spend a relatively lower proportion of their income (even when in nominal terms, they spend much more). Consequently, demand and subsequent emissions from these consumption categories vary less by overall income levels. In contrast, the emissions from the other three product categories are more income-elastic, as reflected by the higher elasticities for ‘Transport’(0.59), ‘Goods’ (0.69), and ‘Services’ (0.58). Richer households spend higher shares of their overall expenditures on these three categories (cf. Figure 4).

Household size has a positive effect on the HCF in all models and it is even the most important variable in the ‘Food’ model (see Table II). The size of the estimated coefficients of the household size dummies varies across the models (Table I). In the ‘Total’ model, a household with two (three) persons emit 20 (26) percent more than a single-person household. The emissions of bigger households are higher than those of smaller households, but emissions vary far from proportionally with household size. This implies that on a per capita basis, emissions fall with growing household size, and quite considerably so in the case of the total HCF. The effect of household size differs greatly according to consumption category. The estimated coefficients for the adult and child variables are smallest in the ‘Energy and housing’ model. An additional household member adds little to heating and other housing-related expenses and subsequent emissions, i.e. the economies of scale effect is strongest in case of energy and housing related HCFs. The coefficients for the adult and children variables are highest in the ‘Food’ model, reflecting that the economies of scale effect is weakest in case of food and drinks related HCFs. The adult dummies have much higher estimated coefficients and are more important in the dominance analysis than the child dummies in all models (except ‘Services’). This reflects that children consume less resources than adults, and hence add far less to overall household emission levels than adults. The category-specific regression results show that the positive effect of children in the ‘Total’ model comes mainly from emissions from ‘Food’ and ‘Services’. The estimated coefficients of children in the ‘Energy and housing’, ‘Goods’, and ‘Transport’ regressions are small (in some cases even negative) and insignificant.

The two variables related to **characteristics of the dwelling** (number of rooms and type of house) emerge as the third and fourth most important variables in the dominance analysis in the ‘Total’ model, accounting for 15 and 10 percent of the explained variance, respectively. This stems from the ‘Energy and housing’ specification, where the housing-related variables have the most important explanatory power (close to half of the total R-squared). The coefficient estimates of the housing-related variables in the ‘Energy and housing’ model imply that the HCFs of households living in semi-detached houses or apartments are respectively 13 and 37 percent lower than those of households living in detached houses, ceteris paribus. In Belgium, detached houses tend to have higher heating requirements than other type of dwellings, with larger surfaces and lower energy performance than apartments. The significant coefficients for detached and semi-detached houses in the regression model for ‘Transport’ probably reflect longer commuting and other travel distances for households that live away from urban centres.

Age (i.e. age of the reference person) has a small and significant positive effect on total emissions (Table I). This might reflect the fact that values and lifestyles change with age, which translates into different consumption and emission patterns (see also Büchs & Schnepf (2013; Golley & Meng (2012). Note however that age is among the least important variables in all models.

The **professional status** variable refers to the household head, with ‘working’ as reference category. The estimated coefficients of the other categories are negative in almost all models, i.e., households where the household head is unemployed, student, incapacitated, homemaker or in pension emit less compared to households where the head is working. Only in the ‘Energy and housing’ model are the estimated coefficients of professional status categories positive. A plausible explanation for this can be that non-working people spend more time at home, which translates into higher heating requirements, and thus higher emissions in the ‘Energy and housing’ consumption category. Based on the dominance analysis, the importance of professional status is the highest in the ‘Transport’ model. Emission from transport are 41 (40) percent less for households with an incapacitated (unemployed) household head, than for households with a working household head. This finding is likely to reflect that unemployed and incapacitated people commute less to work and/or use less emission intensive mobility means (e.g. public transport). Moreover, the fiscally attractive system of “salary cars”, where a car is provided to employees as a way of (social contributions exempt) remuneration which leads relatively many employees to use the car for daily commutes.

The higher the **educational attainment** in the household, the higher the household’s emissions. Compared to the reference category (‘primary or less’), households with an upper secondary or a tertiary education level emit significantly more. We find the strongest association between education and emissions in the regression results for ‘Services’, where a household with tertiary education is associated with 52 percent higher emissions as compared to the reference category. This may be driven by the fact that people with higher educational attainment have different preferences, norms and values related to how to spend their free time, translating into more emission-intensive consumption patterns, than people with lower educational attainment. However, our model cannot capture the exact driving forces behind the positive education-emissions relationship. This certainly is an area for further research.

For the geographical dimension, we can only look at differences according to NUTS1 **region** variable. Belgium has three regions: Brussels-Capital Region (reference category), Wallonia and Flanders. Households in Wallonia emit more than households in Brussels and Flanders. Households in Wallonia emit 10 percent more than those in Brussels, which is mainly driven by emissions from ‘Energy and housing’ and ‘Transport’. This relates to the fact that houses in Wallonia are older and that the pollution-intensive types of heating, coal, fuel oil and wood, are more prevalent. In addition, travel, commuting, and driving distances are longer in Wallonia than in Brussels (Verhetsel et al., 2009), which is reflected in a large and significant effect in the ‘Transport’ regression. We do not have data on driving distances, urban/rural distinction, or the quality and density of the public transport system. Ideally, we would include these variables in the transport regression. We assume that the region variable picks up the effects of these factors.

Occupancy is a dummy variable that distinguishes between owners and tenants. We find that the HCFs of tenants is less that the HCFs of owners. The difference is the biggest in the ‘Transport’ and ‘Services’ models, where tenants emit respectively 24 and 32 percent less than owners, ceteris paribus.

Table II. Results of dominance analysis.

	Total	Food	Energy and housing	Transport	Goods	Services
income	28.3	24.4	10.1	29.2	43.3	32.2
adults	19.8	35.4	10.8	17.0	16.5	14.0
children	3.9	5.0	1.4	1.8	1.8	8.3
age	1.2	4.0	3.5	0.8	0.4	1.0
profstat	5.6	4.8	2.5	11.3	8.7	7.6
educ	6.3	4.8	1.7	7.8	9.6	12.7
region	2.0	0.5	12.1	3.0	0.9	2.8
roomnr	14.6	10.8	22.9	11.1	8.2	9.0
house_type	10.1	5.7	26.1	9.1	4.4	3.1
occupancy	8.2	4.6	9.0	8.9	6.1	9.1

Note: Numbers indicate the percentage contribution of each variable to the overall fit measure (R-squared) in the regressions presented in Table I.

In sum, after controlling for other socioeconomic factors, it appears that there is a relative decoupling between income and emissions. Greenhouse gas emissions increase less than proportional with income because the share of the most polluting consumption categories, i.e. ‘Energy and housing’ and ‘Food’ in total expenditures decreases with income, confirming the bivariate analysis

Mapping (and continuing to monitor) the extent to which different groups in society contribute differently to greenhouse gas emissions not only helps to understand how unequally the contribution to climate change is distributed. It is also important to understand the redistributive effect of climate change mitigation policy. We now look at three policy domains, for which we did an exploratory analysis, notably the case of housing, food and a carbon tax.

4.5 Housing: from pilot projects to large-scale solutions?

In this domain a case study analysis with semi-structured interviews was carried out among the persons and organisations who set up innovative pilot projects aiming to reach vulnerable groups with energy efficiency programmes in Flanders. From this case analysis we distilled three elements that can have a decisive influence on the success of projects aimed at energy renovations for vulnerable residents: (1) financing that puts as little burden on the family budget as possible, (2) appropriate support by a neutral intermediary, both socially and technically, and (3) a community-forming, neighbourhood-oriented approach.

4.5.1 Finance

In current pilot projects a lot of energy goes into finding appropriate financing. Third party financing is often looked at as a solution to a deadlock where a financially profitable investment in energy efficiency is not carried out because of the pre-financing barrier (e.g. FRDO-CFDD, 2016). Possible sources of third-party financing are a bank loan, a contract with an Energy Service Company (ESCO), an intervention by an investment fund or the use of funds through crowdfunding.

Specific characteristics of this (mostly private) type of financing at the same time limit the potential of these instruments to be used to finance the homes of vulnerable groups. In particular, ESCO contracts are particularly common in large building projects (often of a non-residential nature), so that economies of scale can pay for the project costs. A real risk in less large projects is to opt for the low-hanging fruit: relatively limited investments with a rapid pay-back period. After all, the private investors behind these funds need a certain return.

However, a choice of investments that is too short-term in nature can put a house in a kind of lock-in where the renovation did not go far enough, while a subsequent renovation will be long overdue (after all, houses are only renovated every 30 years on average). The specific design of the ESCO structure in the project of Energiehuis Oostende - unique in its kind because it focuses on the vulnerable owner - can offer an interesting precedent, the results of which should also be evaluated in terms of scalability. Possibly, third party financing could play a greater role in financing intermediate entities such as a social housing company or a social rental office, where there is no immediate discretionary power in the selection of interventions to be financed.

A (semi-)public rolling fund, as in the case of Dampoort KnapT OP, offers more possibilities in terms of return requirements. In the case of a government investor, the repayment period can be longer and the return on investment can be interpreted more broadly than the annual real interest rate. After all, the investment pays for itself in other areas as well: extra employment and associated fiscal revenues, increased economic activity and ditto VAT receipts, avoided health problems, avoided energy poverty, avoided CO_2 emissions. Ultimately, this full range of effects is achieved for a vulnerable target group where otherwise little would happen "by itself". A possible bottleneck here is that, in the Belgian context, the government that finances the support measure will often not be the same as the government that can collect the payback effects in the first instance.

For the type of rolling fund envisaged by Dampoort KnapT OP (on a small scale for the time being), the initial investment cost is substantial for the government (here borne by the local social assistance agency), but remains limited in the long run by the guarantee of the return of the fixed value to the fund. The innovative aspect of this financing structure is that it succeeds in temporarily liquidating the equity capital of precarious groups. In the event of theft (sale, inheritance), this sum can be returned. Over such a long period of time, however, it remains a condition that it must be possible to abandon the purely monetary and market-based return requirement. This may make it more difficult for private funds to enter the rolling fund. In the current context where, according to European rules, these investment funds must be treated as expenditure within the annual budget, this remains a bottleneck. Constructions in which the government guarantees the return for private financiers in a rolling energy fund are conceivable, but are financially more disadvantageous for the government budget in the longer term.

4.5.2 Technical assistance and project guidance

Almost all of the projects mentioned above work with an individual renovation supervisor for both the social and the construction process of a renovation. This is a permanent point of contact as a neutral confidant who can assist residents in the decisions to be taken. In this way, the renovation supervisor plays a key role in a successful process. The added value of renovation counselling has meanwhile been recognised and is also provided for in many projects aimed at broader layers of society (and therefore not only vulnerable groups). In this context, it is often referred to as relieving the burden when everything that is involved in a renovation process forms the main barrier for the owner to refraining from renovating. This is no different when working with vulnerable target groups. For those who need extra guidance to follow up the administration of such complex cases, the possibility to call on social and construction-technical advice can increase the project's chances of success by providing support at the most decisive moments.

From this point of view, there is a great deal of potential in further extending the energy scans already carried out by energy consultants among vulnerable groups. Their experience with this target group has taught them to provide tailor-made solutions in which approachability and personal contact are central. Through the social isolation projects with route guidance, this approach is now slowly and modestly extended over time. The new 'Neighbourhood Bonus', which since 2017 has provided €400 per dwelling (unit) when renovating collectively in a group and with a renovation supervisor, also shows that the Flemish government has identified the added value of renovation counselling. Although this may stimulate participation in collective renovation, it only covers a fraction of the real cost of counselling.

Within the 'Warmer Wonen' project, the partners are looking for an innovative model whereby a percentage of approximately 10% of all counselling can be provided free of charge to vulnerable groups. This is covered in a system of co-financing by all parties with an interest in qualitative monitoring of the renovation process: residents, government, and the construction sector. According to their current estimates, they count on an average of €1000 to €1500 per housing unit for the monitoring of the process by a renovation coach.

The fact that good supervision is expensive is demonstrated by the accurate inventory made within the framework of Dampoort KnapT OP of all the implicit and explicit supervision provided by the various actors involved. This was estimated at +/- 8,800€ per dwelling (Hertogen 2017).

The question can be asked as to whether the premiums for assistance can be increased and/or extended by converting investment premiums into assistance premiums in cases where the investment in itself is cost effective, and the barrier lies mainly in the lack of capacity to monitor the renovation process and everything involved. In such a scenario, small premiums and their saved dossier cost could be allocated to continuous guidance organised on the scale of hundreds of dwellings at a time.

4.5.3 A community-forming and neighbourhood-oriented approach

Providing sufficient counterbalance to the socially detrimental gentrification mechanisms of (much needed) urban renewal was one of the explicit starting points of the Dampoort KnapT OP project. They identified the need for models in which people themselves can remain the owners of upgraded housing. The objective of inclusive district renovation meant that the usual approach of using grants and subsidies to stimulate the investment of own resources was avoided. In addition, the intention was to use a strongly supervised 'community-based' trajectory to make the renovation project an anchor to strengthen social cohesion. In this way, regular meetings were organised, where concerns could be shared or start and end moments celebrated. The first wave of this project achieved striking results due to the absence of drop-outs: all ten selected residents successfully completed the project within two years, between 2015 and the end of 2016. According to the participants, the thorough, integrative supervision was in the middle of this.

When collective renovation is carried out on a really large scale in the same neighbourhood, one can take advantage of the advantages of economies of scale such as group purchasing of materials and the reliability of a well-known renovation supervisor compared to contractors. Gommers et al. (2015) estimate that economies of scale can be as high as 20%. In this context, the question can be asked whether the location of public service obligations with the network operators, who financially support interventions by individual actors through ex-post premiums, is the most attractive constellation. This local dynamic may also be triggered by shifting responsibility for public service obligations away from the network operators and towards local contractors, such as collectives, who, with local anchoring and adequate support, can coordinate more far-reaching renovation works.

4.6 Sustainable diet patterns: modelling possibilities with PEACH2AIR

We investigated the impact of a healthier diet on total greenhouse gas emissions and social distribution based on the PEACH2AIR data set for Belgium for the year 2014. The effect on total greenhouse gas emissions of the following scenario was investigated:

- Red meat consumption halved in euro
- Decrease in the consumption of soft drinks, in euros
- Doubling the consumption of fruit and vegetables, in euros

We have found that the pollution of fruits and vegetables in PEACH2AIR is particularly high and that the modelled scenario does not reduce the overall pollution by food, contrary to the existing literature which indicates that a healthier diet can play an important role in reducing greenhouse gas emissions. This is because the indirect air pollution coefficients or CIAPs of PEACH2AIR are based on the Federal Planning Bureau's 'single region' environmental input-output model. The 'single region' environmental input-output model assumes that the same production technology is used abroad as in Belgium. In this specific case and scenario, the impact of greenhouse gas emissions from greenhouse cultivation for fruit and vegetables weighs heavily. Moreover, the aggregation level of greenhouse gas emission source data from this 'single region' environmental input-output model for the CIAPs of food products is quite large, which limits the possibilities of a fine-grained scenario analysis.

To investigate the effect of a change in diet on greenhouse gas emissions, it is therefore appropriate to use a multi-regional input-output model that takes account of differences in production technology at home and abroad. In addition, the level of aggregation of the air pollution data used should be as close as possible to that of the expenditure recorded. Further research will have to show whether it is possible to further develop multiregional input-output models to meet this latter recommendation, given that such models tend to aggregate data at a higher level than single region models do.

4.7 Exploring the heterogeneous effects of a carbon tax and dividend scheme in Belgium

In this analysis, we assess the effects of a carbon tax and dividend scheme on different types of households. We use the 2014 Belgian Household Budget Survey (HBS) to account for household expenditures on heating and transport fuels, and the PEACH2AIR database to account for the respective pollution associated with these expenditures. For a detailed description of the HBS and the PEACH2AIR databases, see earlier sections of this report. The analysis is static and short-term, we assess the immediate effects of the implementation of the carbon tax and dividend. We do not account for behavioural changes, and we assume that the price increases are passed on entirely to the final consumers. The aim of this analysis is to point out which household groups are prone to negative financial effects of the carbon tax on the short term. Our contribution to the Belgian literature is a descriptive analysis of the distributive effects of a carbon tax and dividend scheme taking into account household heterogeneity within low income classes. This approach helps to more precisely target groups that are hardest hit by the carbon tax which is indispensable to designing a fair scheme. The main purposes of our analysis are: (1) to show that even when the carbon tax is largely redistributed among the population, without other accompanying policies, pockets of particularly hard hit households continue to exist among the low-income population; (2) to give an indication of which groups should receive prioritised support for reducing their energy bill.

We simulate a simple tax and dividend scheme in the heating and transport sectors. We focus on these two sectors for two reasons. Firstly, the buildings and transport sectors account for two third of non-ETS GHG emissions in Belgium, and are in the forefront of interest of any carbon taxation scheme. Here we focus solely on emissions of households, thus non-residential buildings and freight transport emissions are not covered in the analysis. Secondly, household GHG emissions stemming from the consumption of heating and transport fuels mainly consists of direct emissions, compared to which indirect emissions are negligible. Thus, we do not have to account for complex supply chains and emissions happening outside of Belgium.

In the simulations, we assume that a carbon tax of 10 or 110 €/tCO2e is levied on heating and transport fuels based on their carbon content. We calculate the tax payments of households by first calculating their emissions based on the emission coefficients of the PEACH2AIR database, and then multiplying these emissions by the tax. Government revenues are calculated by adding up all the tax payments of all the households. We simulate two redistribution schemes: the redistribution of the revenues equally to all citizens in the form of a cash transfer, and a redistribution of the revenues in form of an increase in existing benefits. Households that receive some kind of benefit can be considered as vulnerable requiring special attention in the design of the carbon tax and dividend scheme. We identified households that receive the following benefits: unemployment benefits, widow's pension, child benefit, sickness and disability benefits, benefits in kind). Lastly, we also varied the amount of the dividend. We simulated the redistribution of either all the government revenues from the carbon tax or the half of it. The latter choice was motivated by the consideration that the low-carbon investments also need to be financed, and the government might consider using part of the carbon tax revenue for this aim. Table III summarizes the details of the scenarios.

Table III. Summary of simulated scenarios

Scenario	Tax base	Level of tax	Redistribution	Dividend
1	heating	10€/tCO2e	flat rate	full / half amount
2			increase in benefits	
3		110€/tCO2e	flat rate	
4			increase in benefits	
5	heating and transport	10€/tCO2e	flat rate	full / half amount
6			increase in benefits	
7		110€/tCO2e	flat rate	
8			increase in benefits	

In this section, we present a selection of the results of the analysis We focus on key graphs and messages of the analysis.

Figure 8 and Figure 9 show the increase in the cost of heating and transport fuels as a result of a 110€/tCO2e carbon tax. In case of heating fuels, we see the biggest cost increase in case of the most emission intensive categories: wood, other fuels, and coal (122, 90 and 81 percent cost increase, respectively). The price increase of other fuels is also considerable, the cost of natural gas and heating oil grow by 42 percent. In case of transport fuels, the cost increase is more moderate, the cost of diesel and gasoline grow by 27 and 19 percent, respectively.

Figure 8. Increase in cost of transport fuels per unit bought with a carbon tax of 110€/ tCO2e

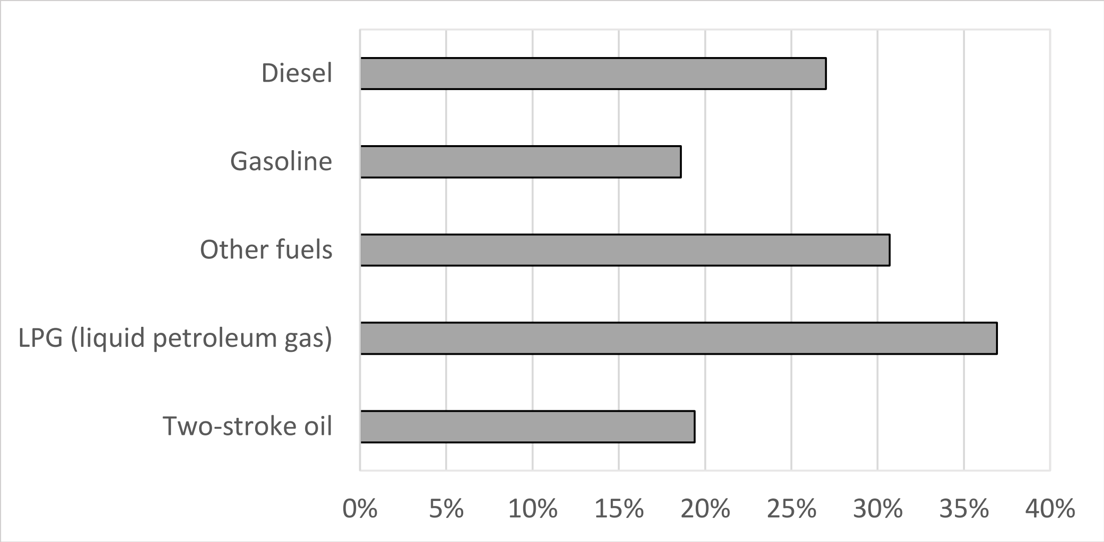


Figure 9. Increase in cost of heating fuels per unit bought with a carbon tax of 110€/ tCO2e

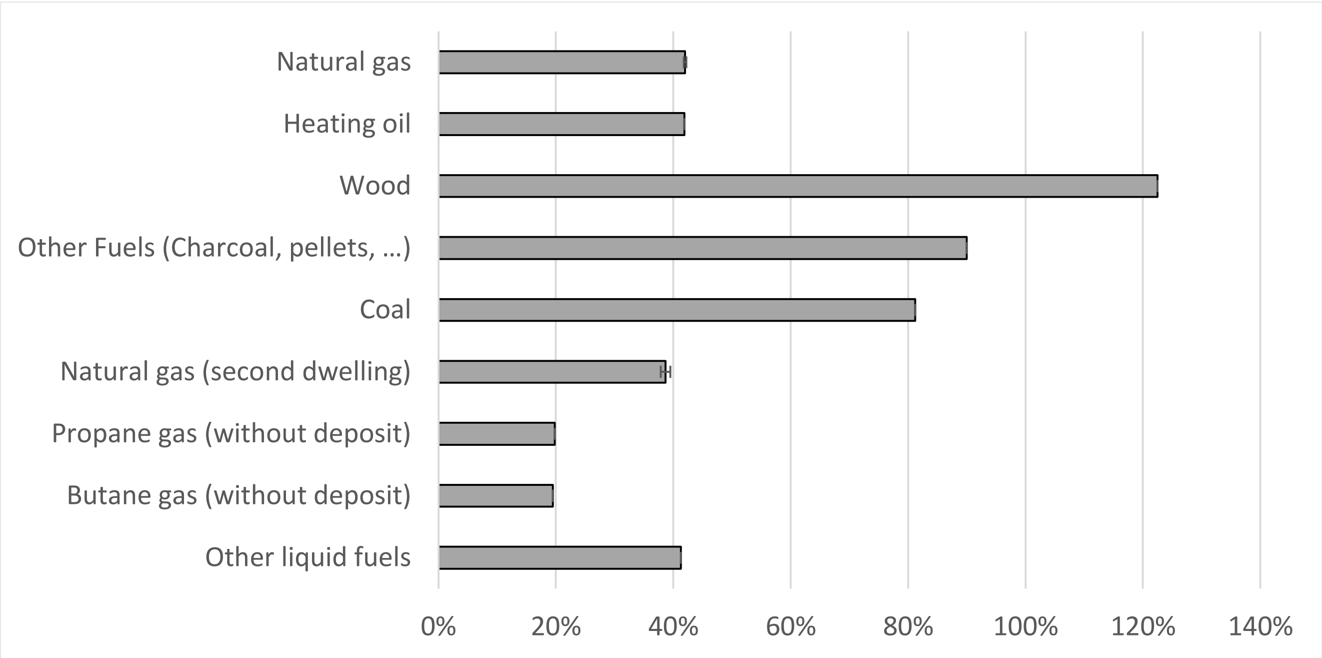


Figure 10 and Figure 11 show how the tax is distributed across income deciles under the 10€/tCO2e scenario. While absolute tax payments show a slightly increasing trend on Figure 10, when these payments are expressed as a percentage of income on Figure 11, the regressive effect nature of the carbon tax is clearly demonstrated. Households at the top of the income distribution spend lower percentage of their income on the tax than households at the bottom. This trend is similar when the higher tax level is simulated and it justifies the need for the redistribution of the revenues of the tax to compensate households that have to face the biggest losses as a percentage of their income.

Figure 10. Average tax payments per income decile

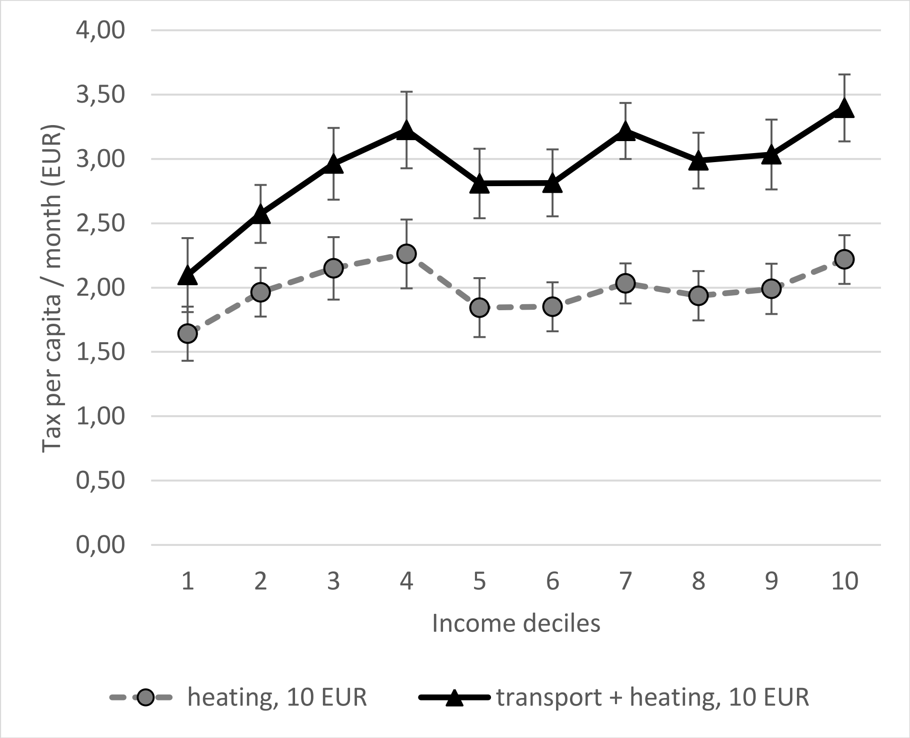
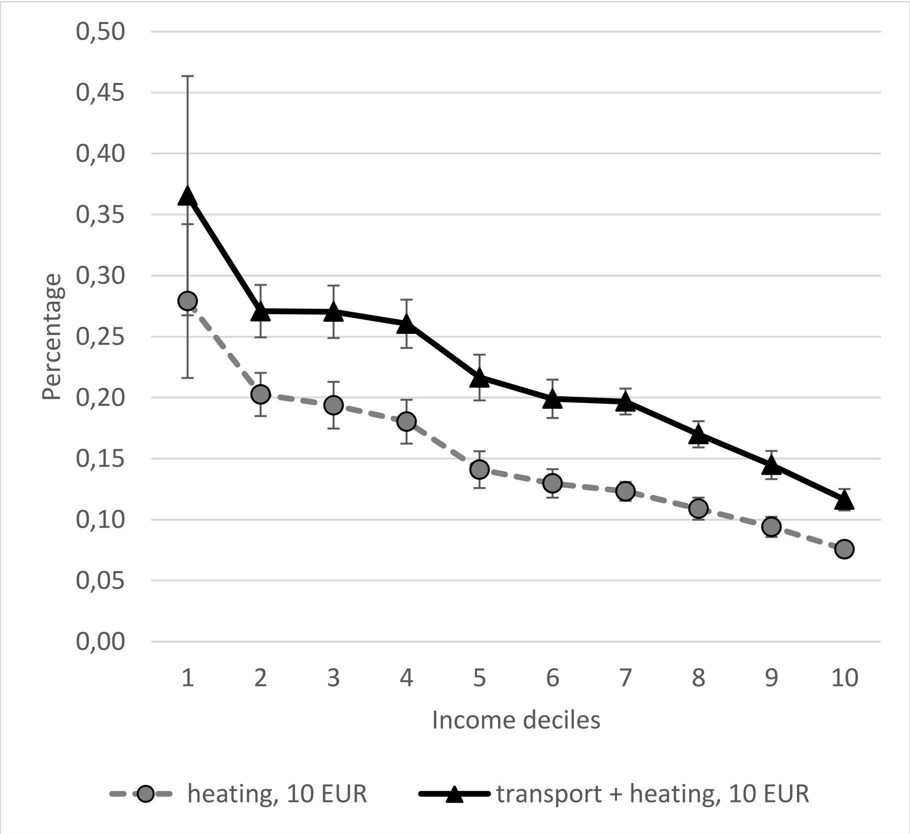
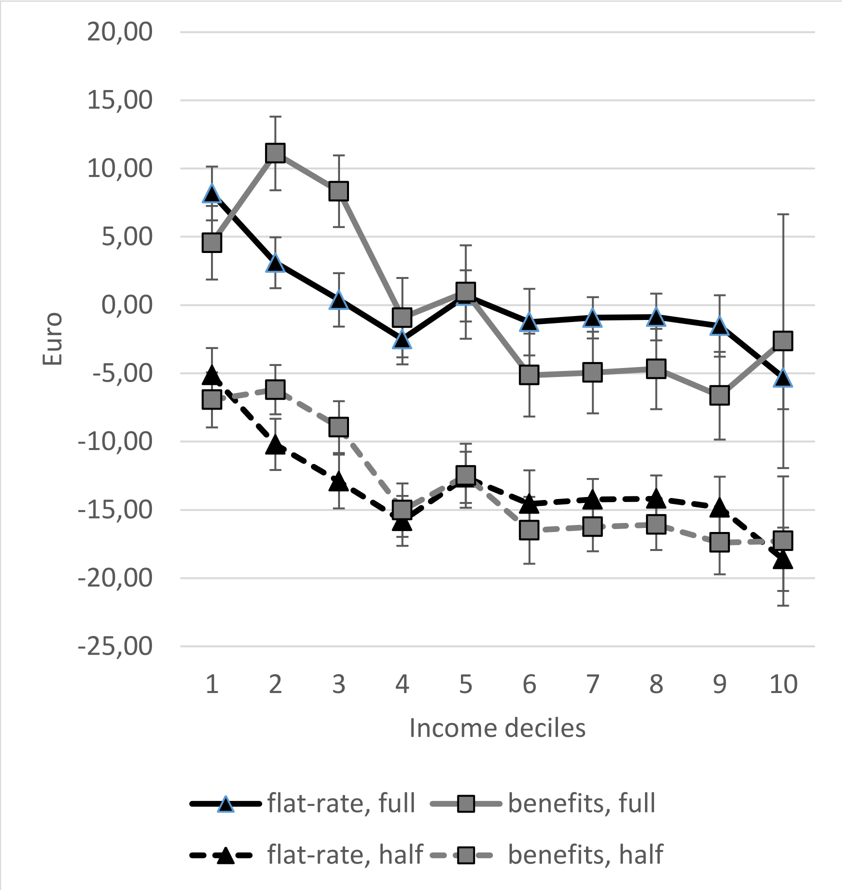


Figure 11. Average tax payments as percentage of income across income deciles



When the revenue of the carbon tax is recycled, the regressive effect of the carbon tax is alleviated (Figure 12). The bottom three income deciles see a higher gain or lower loss than the other income deciles. In the scenarios where all the revenues are redistributed, the bottom two/three income deciles are even net winners of the scheme, with gains up to 11 euros per person per month. When only half of the revenues are redistributed, the net effect is negative in all income deciles, although the loss in the richest decile is about 3.5 times as high as in the poorest decile.

Figure 12. Average per capita gain/loss per month in scenarios 7 and 8.



As mentioned earlier, it is crucial to investigate the heterogeneity of the estimates within the income deciles. Figure 13 demonstrates that the net gain and loss varies widely within each income decile and the spread of the gain and loss as a percentage of disposable income is higher towards the bottom of the distribution.

We also explored the characteristics of those living on a low income who would face a relatively large loss in the scenario of a € 110/tCO2e carbon tax, with half of the revenue recycled as a flat-rate benefit (scenario 7). As there is some mismatch between income and expenditure, we further restricted the population at risk to those with equivalized expenditures in the first two quintiles. Figure 14 represents the share of tenants among all the population, among the first three income deciles and among the group of households within the first three income deciles and first four expenditure deciles that would face a loss of at least 2% of their disposable income. The share of tenants is significantly lower in the total population than among the low-income/low-expenditure households experiencing a big net loss of the carbon tax and dividend scheme and the first three income deciles. This points to the importance of treating possible split incentive issues among the most vulnerable households.

For the same scenario, we also looked into the household composition of those on a low income and with low expenditures facing a loss of at least 2% of their income ("big loss"). Figure 15 and Figure 16 compares their average household composition to the one found in the total population ("all") and all households in the bottom three deciles ("D3"). Remarkably, those on a low-income with relatively low expenditures and facing a relatively high loss consist disproportionally of single person households and couples without children, implying that children would be relatively well (but not fully) protected under the scheme, except for children in single-parent households.

Figure 13. Distribution of net gains/losses as a % of disposable income, by income deciles in scenario 7 (flat-rate, half dividend)

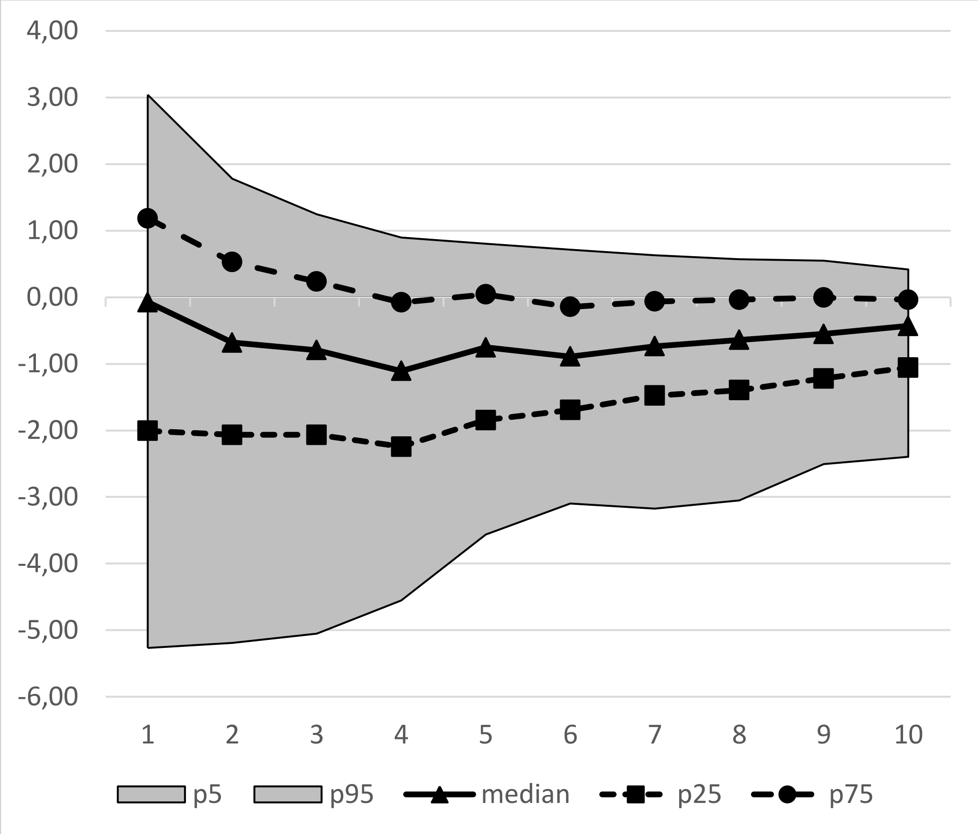


Figure 14. Share of tenants among all households, households in the 1st three income decile, and among households

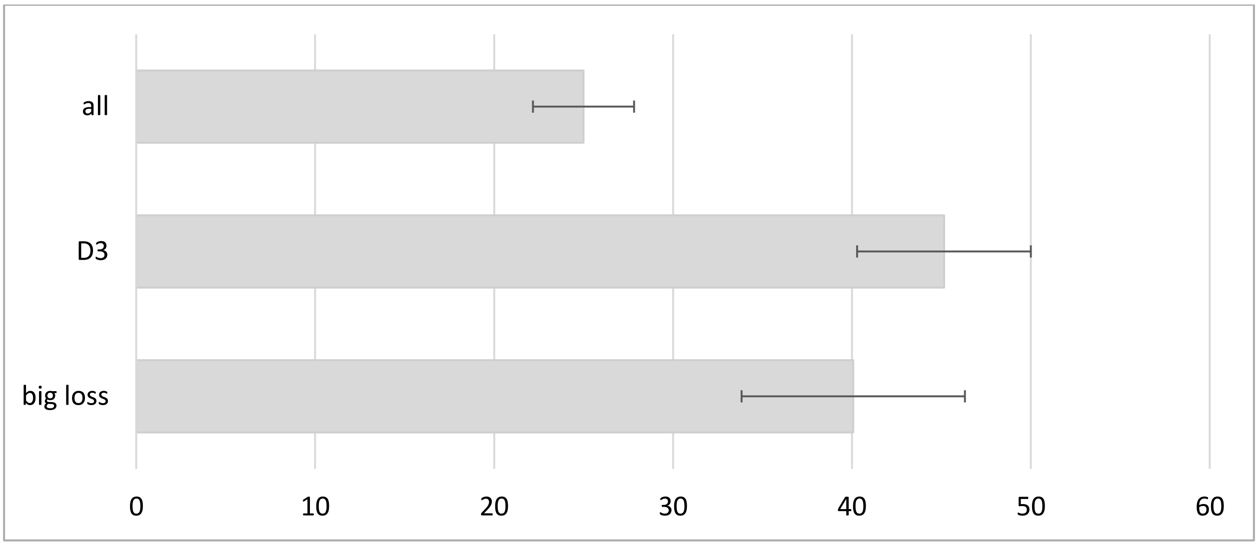


Figure 15. Household composition among all households, in the first three income deciles (D3) and among the households facing the biggest net loss of the carbon tax and dividend scheme

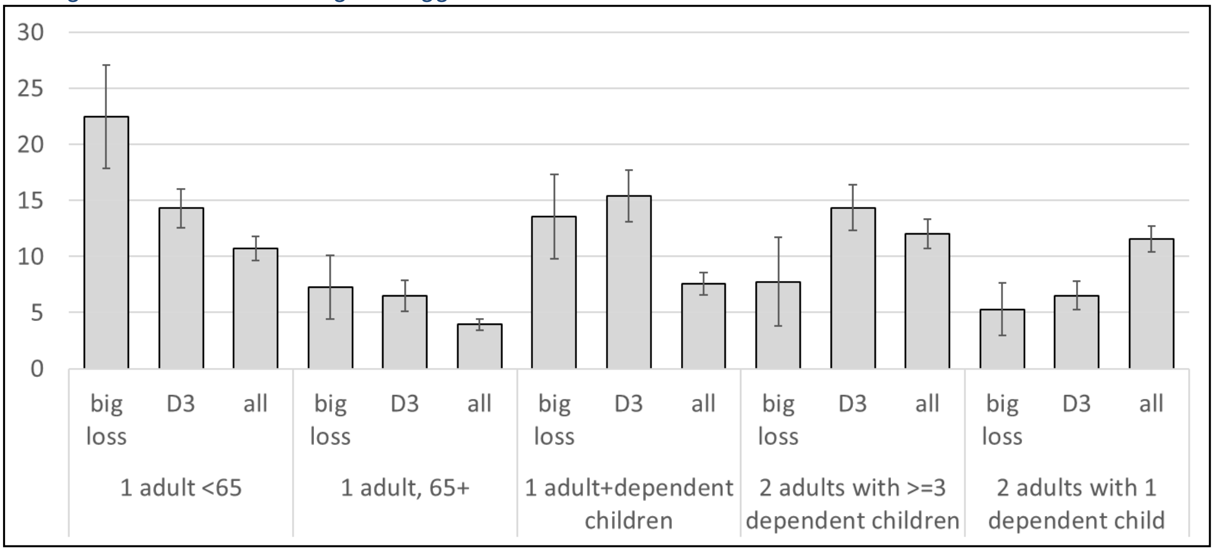
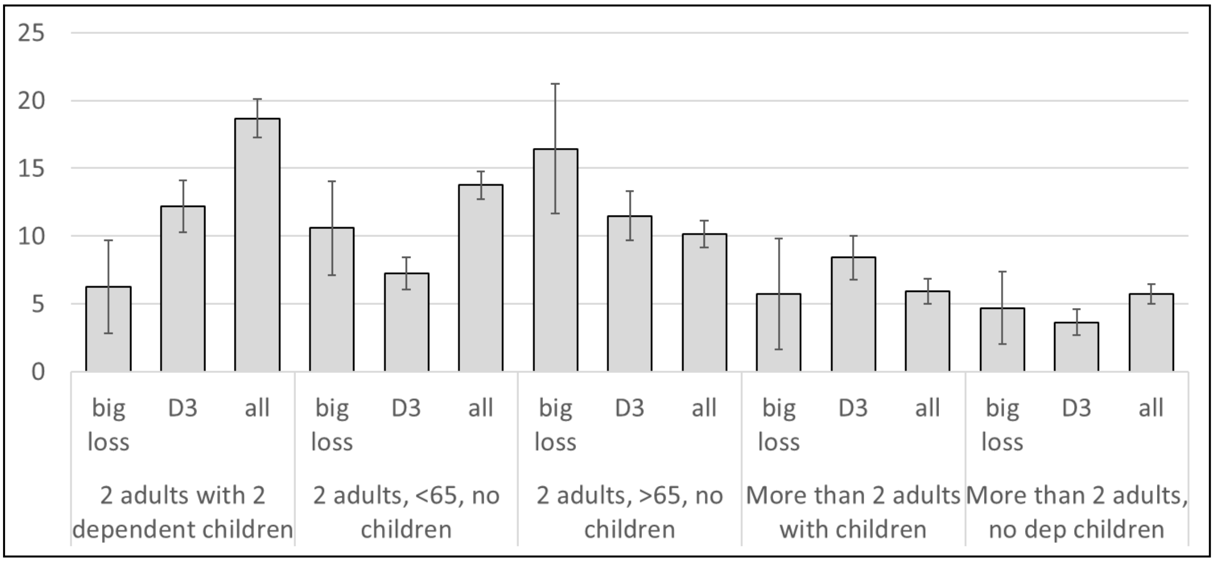


Figure 16. Household composition among all households, in the first three income deciles (D3) and among the households facing the biggest net loss of the carbon tax and dividend scheme



5 CONCLUSION AND RECOMMENDATIONS

A socially just climate transition ensures, among other things, that the most vulnerable do not have to bear a disproportionately heavy burden and that the benefits of climate policy do not flow mainly to the more well-off. In other words, a socially just climate policy at least does not increase poverty and inequality, but the ambition can go further: a socially balanced transition can also lead to more social justice and reduced social inequality. Moreover, the fight against poverty and inequality is an important ally for reducing greenhouse gas emissions in such a way that the earth does not heat up by more than 1.5°C, in an inclusive social and ecological story that offers perspective.

In this context, we successively discuss 'thoughtful compensation' and 'eco-social policy' as conceptual policy paths that can be taken further. Finally, we consider how a more equal distribution of income can also be combined with a more effective climate policy.

5.1 Well-considered compensation

Taxing polluting economic activity is an important part of an economic environmental policy (Bachus 2019). However, depending on the sector and the design of a carbon tax, it can generate regressive outcomes, with poorer households contributing a relatively larger proportion of their disposable income, directly and indirectly, to this tax than richer households.

A well-considered CO_2 tax with socially sensitive "recycling" of the revenues, is an economically efficient system to reduce CO_2 emissions across all economic sectors. Recycling means that they are injected back into society in a certain way. This can be done, for example, in the form of a so-called carbon dividend, where the proceeds are redistributed equally or according to family size. With the Greenhouse Gas Pollution Pricing Act of 2018, Canada has introduced such a carbon fee and dividend at federal level, of which is expected that higher incomes will be net contributors, while the vast majority of families will win from the system. Alternatively, "progressive" recycling can be set up where lower incomes would receive a higher amount, or resources can be used to invest in public services such as education and health care. The transparency and predictability (over time) of such a system can increase its acceptance by citizens and businesses.

Depending on the way in which compensation measures are designed, some (poor) households may in practice loose out after all. The great heterogeneity of the group of 'vulnerable households' on the determining parameters such as family size, housing type, insulation degree, heating system, energy consumption, etc. makes it likely that the same compensation will mean a net gain for one family, but it will still be insufficient to make up for the loss of income for those households with the most carbon-intensive consumption patterns. Complementary to measures that tax and compensate, attention will therefore continue to be needed to support low-income households in the transition to a less carbon-intensive consumption pattern, which often requires an initial investment.

Although very limited in setup, our empirical analysis on a carbon tax in Belgium shows that the strong heterogeneity in the low-income population in terms of their energy consumption and income situation is a critical factor to take into account for designing an effective and fair carbon tax and dividend scheme. Even when a large part of the raised revenue is recycled, there is very strong heterogeneity in the low-income population in terms of the gains or losses people on a low income would suffer. This implies that other policies should accompany such a scheme, prioritizing measures that reduce energy consumption of the most vulnerable households, by increasing housing quality and energy efficiency of dwellings and heating systems. Also, this analysis shows that it is possible to use the PEACH2AIR database for better understanding which groups would risk to lose most from various setups of carbon tax and dividend schemes, which should be helpful for designing not just the tax-dividend scheme but also for better targeting the aforementioned essential accompanying policies. Finally, the analysis shows that the distributive impact of a small carbon tax of 10EUR/tCO2e would be very limited, implying that this is a scheme that could be implemented as a test case, with a relatively low risk of jeopardizing the already vulnerable income position many households have to cope with. This could help to finetune the scheme before the tax is raised to a more substantial level to achieve the desired carbon reduction effects.

5.2 Eco-social policy

Eco-social policy explicitly prioritises the reconciliation of ecological and social objectives (Gough 2017). This type of policy is about measures that at the same time tackle the unequal distribution of both the responsibility for and the consequences of emissions. Eco-social policy can take many forms. Among other things, it concerns investment in infrastructure and the provision of public services aimed (among other things) at low-income groups. An important policy area in this context is, of course, housing, given the large share of energy from housing in emissions and in the budget of poorer households (see Figure 4). Support for low-income groups when renovating old dwellings to the required energy level is essential. Providing sufficient and CO_2-neutral social housing is also an important component of housing policy. More equal ownership of energy production, for example in the form of cooperatives or citizens' initiatives, can also play an important role. More social employment in the circular economy can increase and strengthen this sector, while combating poverty among the long-term unemployed and people with a short education. Much can also be done in the field of transport, for example by providing adequate public transport in general, but in particular for areas where more vulnerable households live (both urban and rural). The (re)design of traffic infrastructure that gives more space to vulnerable road users is also eco-social, given the unequal distribution in transport modes.

The social dimension of ecological policy must not be neglected: in order to achieve the climate objectives, a general effort is needed. If, for example, up to a quarter of households were unable to participate - because they do not have the financial capacity to finance necessary investments while at the same time having to contribute disproportionately to climate-related levies or taxes - this would be inefficient, unfair, and could exacerbate (feelings of) disadvantage and exclusion. At the same time, a socially equitable climate policy also holds great potential for an inclusive social narrative for a post-carbon society in which quality of life, health and well-being are paramount. From work to housing, well-designed climate measures can generate positive side-effects for all. Very directly, in the form of cleaner air, more access to greenery, more comfortable housing, sufficient food and drinkable water, but also indirectly: a stronger social neighbourhood fabric and more and better quality leisure time. The direction of this dynamic between the social narrative of the climate transition and its support depends, among other things, on the nature of the climate measures taken and the extent to which their social justice is proactively taken into account.

5.3 Strengthening social policy

An important instrument for a socially just climate policy is the 'traditional' social policy. Adequate benefits, a progressive income tax and efficient public services are essential ingredients for this, which can help reduce income inequality and poverty. With a more equal initial income distribution, the distributive effects of climate measures will be less heterogeneous. This typically goes hand in hand with greater support for (government) intervention. Also, economic and political power concentrations will remain more contained, where in very unequal societies they can play an important role in preventing and weakening environmental policy, and thus in accelerating and increasing environmental damage (Knight et al. 2017).

Similar mechanisms have also been demonstrated between individuals in the very extensive literature on experiments related to public goods. In an experimental setup, it is investigated how different factors influence the participants in their choices for contribution and cooperation for the realisation or protection of a public good, such as street lighting or national protection, but also the atmosphere (and the concentration of CO_2 particles in it). A robust finding is that the collaboration between participants decreases as inequality increases in the resources allocated to different participants. Inequality makes it more difficult to agree on contributions to and management of public goods (Zelmer 2003; Anderson et al. 2008; Hauser et al. 2019).

The findings seem to indicate that strong institutions for redistribution and strong institutions for tackling environmental and climate challenges are not independent of each other (Duit et al. 2016; Gough 2016). Historical analysis shows how societies with a more equal distribution of income and wealth were better able to deal with the environmental threats that affected them (Van Bavel et al. 2018). The available data for today's welfare states show a diffuse picture, from which we can conclude that a stronger environmental policy is not an automatic consequence of more egalitarian social structures (Koch & Fritz 2014). A strong welfare state is therefore not a sufficient condition for an adequate climate policy, but the avoidance of increasing inequality does seem to be a necessary condition if we are to have any chance of limiting global warming to well below 2°C.

The results of the IPCC exercise with Shared Socioeconomic Pathways (SSPs) also point in this direction on a global level. For the sixth IPCC Assessment Report to be published in 2020-2021, the 5 SSPs with different scenarios concerning social, economic and societal developments serve as input to diversify the business-as-usual scenario. For example, the projections on emissions, CO_2 reduction and the impact on the final temperature follow a different trajectory in a world that is gradually but firmly committed to sustainability and inclusive development (SSP1), than in a world order of regional rivalry, where policy focuses mainly on protecting one's own region (SSP3) or where market forces for technological innovation are mainly expected (SSP5). The results show how much more difficult (to virtually impossible) it is to achieve the Paris objectives in scenarios where inequality continues to rise to record levels, social cohesion crumbles into unrest and conflict, and public institutions collapse (Riahi et al. 2017).

5.4 Recommendations

The climate problem is entrenched with social inequality. There is a huge inequality in contributions to climate change and in vulnerability to its effects both at a global level and within nation states. This "double injustice" becomes "triple injustice” (Gough 2013) when climate policy outweighs the disposable income of poor households over that of rich households. However, the apparent trade-off between social and environmental objectives does not happen automatically, but depends to a large extent on the design choices in policy measures. When climate policies in their design do not take into account social heterogeneity of the target group, this will often lead to socially adverse effects. Nor can this be an argument for tempering the climate ambition: due to their higher vulnerability, poor families are also the most exposed to the intensifying climate risks. The challenge that policy faces is therefore to shape a bold climate policy in such a way that it will be able to meet the challenges without increasing inequality. In fact, the transition to a carbon neutral society can be a powerful lever to reduce social inequalities and strengthen inclusion.

We elaborate this central point in three domains of more concrete recommendations below.

5.4.1 Improving the procedural social justice of climate policy measures:

Policy analysis in general, and our analysis of climate scenarios in particular, shows that social science is poorly integrated into the public policy process. However, a huge body of scientific literature has developed around issues of social, climate, environmental and energy justice. But the knowledge produced today in various scientific disciplines is not sufficiently confronted and interrelated. Measures for a low-carbon transition too often remain solely under the seal of innovation, that mix of technology and market. If we want policies that better reflect all aspects of reality, it is essential to draw on the full range of available knowledge.

In terms of distributive justice, it seems natural to assess the impact of programmes by paying attention to the poorest 10 or 20% of the population. This is certainly an improvement over policy measures that would be taken only in relation to an average. However, each income decile masks very different realities, and the effects of a distributive policy need to be analysed as finely as possible. Moreover, the focus on the poorest should not obscure the fact that the wealth gaps are especially large in the last decile and especially the last percentile. Insofar as a more egalitarian society is a more sustainable society, it therefore seems normal to also develop policies towards the richest so that the "environmental ceiling" is not pierced. A policy based on "consumption corridors" aims to determine basic needs but also absolute (non-tradable) ceilings.

The principle of recognition is a principle of justice that may seem complicated to implement because it must lead to a political admission of the existence of unjust situations and, above all, to taking measures to remedy them. However, there are many situations that appear unjust and it is not easy to sort them out. A good method is therefore to listen to the actors and associations that are in contact with various social problems, particularly poverty. These associations are the spokespersons for the people they meet and are able to translate the speeches they hear and the situations they observe. Public policy would benefit from balancing the sources of information by seeking information from actors who are active in a variety of fields.

Finally, the principle of procedural justice requires that the most disadvantaged populations be involved in the implementation and evaluation of policies, even though they are most often excluded from them, whether voluntarily or not. However, it is difficult to mobilise these populations directly, particularly out of shame and fear of controls (to which they are constantly subjected), and it is therefore necessary to strengthen the associations that can represent them.

5.4.2 Enabling renovations for energy efficiency, also for vulnerable households

From both an ecological and social point of view, it is essential that more vulnerable groups also have access to energy-efficient housing on a larger scale. The dominant strategy of ex-post subsidies and premiums is not enough to achieve this. Targeted and coordinated policy measures are needed to make energy renovation of dwellings accessible to low-income families, as they face specific barriers to energy renovation. These barriers differ in part for tenants on the private housing market, social housing tenants and precarious owners. Meanwhile, various (pilot) projects show that it is possible to overcome these barriers. For this, creativity and motivation are of decisive importance. The examples show that specific barriers require specific action. The big question is how existing initiatives can be strengthened, expanded and scaled up.

Of course, policymakers need to take responsibility for this, as do semi-public actors such as social housing companies. Funding appears to be the most important major stumbling block to a rapid improvement of the housing park for vulnerable families. Existing projects show that there are alternatives that can lead to 'financial relief', different stakeholders could contribute to the design and evaluation of a range of effective financing techniques that go beyond grants to individual citizens and are adapted to the possibilities and needs of different target groups (precarious owners, private tenants, social housing companies, innovative collectives and cooperatives) and financiers. Calculating investment risks and total cost effectiveness are important elements in this respect. The latter in particular is a major challenge. After all, investments in energy-efficient housing can go hand in hand with important indirect payback effects, such as a reduction in health costs (for residents), environmental effects, the reduced need for social tariffs for gas and electricity, local employment and others. It is much less obvious to identify these in an adequate way. If new research succeeds in quantifying this in a sound way, the government can continue to invest, in a more informed way, and perhaps with more conviction, in instruments that realise energy renovation of homes of vulnerable households on a large scale.

A second major stumbling block appears to be the cooperation of partners on the ground: actors in the social housing market are far from realising their potential and citizens are confronted with many non-financial barriers. Neutral specialists who take on the coordination of renovation projects and a neighbourhood-oriented approach appear to be important key factors. In addition to appropriate financing, the combination with route guidance seems to achieve the most successful results. This meets the need for clear, impartial and coherent information, expertise, a permanent point of contact and coherent coordination of interventions, administration and financing. However, we see that there are projects that are deadlocked, despite an initially promising design. Further research should further map the success factors, and come up with innovative strategies that could be applied on a larger scale in Flanders. In addition, focusing more on a neighbourhood-oriented approach could bring additional benefits. The question remains how to finance this in an efficient way and how the policy framework could be adapted to apply a neighbourhood-oriented project on a larger scale.

5.4.3 Further research infrastructure

Although the infrastructure developed in the SUSPENS project is of sufficient quality for many types of descriptive analysis and static microsimulations, there is still quite some room for improvement. Areas for improvement include: (1) more recent data; (2) improvements with regard to imputing direct emissions; (3) improvements regarding indirect emissions; (4)

improvements regarding the richness of the dataset used; (5) improvements in the simulation infrastructure. In what follows, we briefly discuss each of these in turn.

There is a need for recent microdata on socio-economic characteristics and GHG emissions. Currently we worked with the 2014 Household Budget Survey, and the input-output model related to 2010. Obviously, within a rapidly changing landscape and technological developments, being able to work with more recent data, and scenarios for how technology has evolved across the economy, is critically important when using the simulations not just to describe the situation of some time ago, but also to inform current policy debates and planning for the future.

Regarding direct household emissions, an important shortcoming of the HBS is that electricity and gas consumption is often recorded jointly, and the exact share of each is imputed by ADSEI. It is hard to evaluate the precision of these imputations. Furthermore, more adequate information on (the use of) company cars, the type of fuel and amount of fuel consumed is an important shortcoming of the data. Although this does not relate to expenditures by households (insofar they are subsidized by companies), it would be extremely beneficial if more precise information on this would be available. More information on other modes of transport would also be extremely valuable, for instance with regard to flights. This information is now often included in packaged deals for holidays, rather than recorded separately. Recording business flights separately, might also be useful, even if they cannot be considered, strictly speaking, part of the household carbon footprint and are in principle included in the indirect emissions.

Also the quality and precision of the estimated indirect emissions could be improved. As was mentioned earlier (see section 3.1), one problem is that we built on a single region input-output model. The use of this model has the advantage that it is relatively detailed in terms of breakdowns by product categories. However, a major drawback is that it is assumed that imported goods and services apply the same technology as similar sectors in Belgium. This can lead to misleading results when zooming in on specific product categories which are to a large extent imported (cf. food). Extending the Belgian input-output model to cover the most important other regions would create an important added value in this respect. Also, for specific analysis it might be useful to combine the estimations of GHG emissions with results for Life-Cycle-Assessments (LCA) databases, when focusing on the environmental impact of specific products (e.g. organic vs. non-organic food). More in-depth analysis of assumptions, strength and weaknesses of these methods is essential for researchers to be able to provide more precise and reliable estimates about the distribution of GHG emissions across households, and options for emissions reduction. It would also be useful to model GHG emissions under various assumptions and projections of technological development such that more up-to-date estimates can be obtained.

Furthermore, the research infrastructure could be improved by enriching the current microdata with more detailed information on factors that are relevant to the carbon footprint of households, including aspects that could be the focus of policy interventions. Examples include more detailed information about transport behavior, the use and availability of transportation modes, housing characteristics, geographical location, and more detailed information on some socioeconomic characteristics (living standards, labor market status, etc). In an ideal world, having panel data of households on consumption expenditures would also be extremely valuable.

Finally, it would be very valuable to strengthen the microsimulation infrastructure, for instance by adding a model on the effects of price changes on consumption patterns, linking up with macro-level models, and better integrating the household budget survey (matched with IPCAL) in the EUROMOD infrastructure. This project (and previous projects) have made some important steps into that direction, but there is little doubt that this could be developed further, with important benefits for the possibilities and quality of simulating the socio-economic effects of policy change.

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6 DISSEMINATION AND VALORISATION

The topic of linking social and environmental inequalities, and then especially in the framework of the transition towards a low-carbon society, has not only received increased interest in academia, but it has increasingly been the subject of fierce public and policy debates. The main aim of the SUSPENS project was therefore to carry out analyses which are also able to better inform public actors. Throughout the project duration we have shared our findings among both academic and policy circles as well as the wider public. We have attended and presented on numerous academic national and international conferences, workshops, seminars, etc. We have also organised ourselves events for experts in the framework of the project, as well as a final conference in March 2020 which was open to all interested persons. We list here our dissemination and valorisation activities:

Organisation of workshops, roundtable and conference:

- Organisation of Roundtable at FPB – 11.02.2016 Sociale en milieudoelstellingen in een transitie naar een koolstofarme samenleving
- Organisation of Expert Workshop by CSB on environmental pressure coefficients for household consumption, in Antwerp, 26-27 June 2017. The expert workshop welcomed experts from four European countries. The experts are authors of academic publications that connect environmental pressure coefficients with micro-level household consumption data. The aim of the workshop was to (i) learn about each-others research agendas, and (2) carry out in-depth discussions on both substantive and methodological issues regarding the use and interpretation of environmental pressure coefficients for analysing household consumption data. By the end of the workshop, participants gained a better understanding of methodological issues, caveats, and solutions to overcome these caveats in this specific and relatively new strand of literature.
- Organisation by FPB of expert seminar on 6 June 2019 on "Profiling of greenhouse gas emissions by households' consumption in Belgium" at the Federal Planning Bureau
- Organisation of the project's final conference on 6 March 2020 "Reconciling Environmental and Social Dimensions in the Transition towards a Low-carbon Society" – Royal Library of Belgium, Brussels, 9:15 – 16:45. Programme available here. Presentations available here.

Presentation at conferences, seminars, workshops:

- Josefine Vanhille - Presentation of 'Energie-efficiënt wonen, ook voor gezinnen in armoede? Beleidspistes gericht op private huurders, sociale huurders en precaire eigenaars' at Research Day University Foundation Poverty Reduction, 18 October 2017.

- Petra Zsuzsa Lévay – Environmental impact of Belgian household consumption: assessing the assumption of homogeneity of price. The Just Transition Conference. Edinburgh, UK, 1-2 March 2018.
- Petra Zsuzsa Lévay – participation 2018 Green Growth and sustainable Development (GGSD) Forum and the Green Growth Knowledge Platform (GGKP)'s Annual Conference "Inclusive Solutions for the Green Transition". Paris, 27-29 November 2018.
- Petra Zsuzsa Lévay - Determinants and distribution of greenhouse gas emission of Belgian Households. Research Seminar on Socially Fair Transition to a Green Economy organized by the Social Situation Monitor. Brussels, BE, 14 May 2019.
- Petra Zsuzsa Lévay & Josefine Vanhille – Determinants and Distribution of Greenhouse Gas Emissions from Belgian Household Consumption". Lunch Seminar at the Herman Deleeck Centre for Social Policy. Antwerp, BE, 24 June 2019
- Petra Zsuzsa Lévay & Josefine Vanhille – Distribution of GHG Emissions Related To Household Consumption in Belgium. Conference Paper presented at ECINEQ conference in Paris 3-5 July 2019.
- Gerlinde Verbist – Distribution and determinants of household greenhouse gas emissions in Belgium, presented at the 17th ESPAnet Conference Stockholm, Sweden, 5-7 September.
- Petra Zsuzsa Lévay – Determinants and Distribution of Greenhouse Gas Emissions from Belgian Household Consumption. PhD expert course 'Low Carbon Economy' (Antwerp, BE), 10-12 September 2019.
- Gerlinde Verbist – Environmental policy and Tax-benefit microsimulation, presentation at presentation at EUROMOD workshop, Milan, 24 September 2019
- Gerlinde Verbist – Distribution and determinants of household greenhouse gas emissions in Belgium, presented at workshop 'Welfare recalibration and the ecological crisis: research topics, approaches and findings for a sustainable transition', University of Pisa, 11 November 2019
- Josefine Vanhille – presentation of 'Sociale ongelijkheid in het klimaatvraagstuk' at
  - Boekenbeurs Antwerpen, 8 November 2019.
  - Ecopolis, Brussel, 10 November 2019.
  - Festival van de Gelijkheid, Triodos Gent, 28 November 2019.
  - Seminar "Klimaat & Economie", Faculty of Economics, UGent, 11 February 2020.
  - Seminar Fac. History, KULeuven, 18 March 2020.
- Gerlinde Verbist – presentation of 'Sociale ongelijkheid in het klimaatvraagstuk'. UCSIA Workshop "De Sociale Staat van het Klimaat", 24 October 2019.
- Tim Goedemé, 'The distribution of direct and indirect greenhouse gas emissions of household consumption in Belgium', INET Researcher Seminar, University of Oxford, 7 November 2019.
- Tim Goedemé, 'Income inequality and the distribution of direct and indirect and indirect greenhouse gas emissions of household consumption in Belgium', Institute for Social and Economic Research, University of Essex, 20 November 2019.

- Petra Zsuzsa Lévay - Data and modelling for analyzing climate change policies. JRC Fiscal Policy Modelling Workshop (Seville, ES). 12-14 February 2020
- Petra Zsuzsa Lévay - Measuring household's carbon footprint from consumption data: does a unit instead of a monetary approach make a difference? CSB Lunch Seminar 18 February 2020.
- Josefine Vanhille – Policy routes towards residential energy efficiency: a social distribution Perspective. CSB Lunch Seminar 3 March 2020.

More information can be found on the SUSPENS-website:

http://suspens.net

7 PUBLICATIONS

7.1 Peer-reviewed publications

Goedemé, T., Coene, J., Hubeau, B., van Damme, R. (2017) Armoede, energie en wonen: creatieve ideeën voor een toekomst zonder energiearmoede, Proceedings Research Day University Foundation Poverty Reduction (USAB), 18 October 2017.

Levay P., Vanhille J., Cooreman G., Frère J.-M., Verbist G., Goedemé T. (2019), 'De sociale verdeling van de broeikasgasuitstoot in België', in Coene J., Raeymaeckers P., Hubeau B., Marchal S., Remmen R., Van Haarlem A. (eds). *Armoede en Sociale Uitsluiting. Jaarboek 2019*, Leuven, Acco, pp.107-123.

Vanhille, J., Goedemé, T. & Verbist, G. (2019), 'Sociale ongelijkheid in het klimaatvraagstuk', in S. Dierckx (ed.), Klimaat en sociale rechtvaardigheid, Oud-Turnhout: Gompel&Svacina, pp.61-83.

Vanhille, J., Verbist, G., Goedemé, T (2017), 'Energie-efficiënt wonen, ook voor gezinnen in armoede? Beleidspistes gericht op private huurders, sociale huurders en precaire eigenaars', in T. Goedemé, J. Coene, B. Hubeau, R. van Damme (red.) Armoede, energie en wonen: creatieve ideeën voor een toekomst zonder energiearmoede, Proceedings Research Day University Foundation Poverty Reduction, 18 October 2017.

7.2 Working papers

Cooreman Gertjan, Frère Jean-Maurice, Levay Petra, Vanhille Josefine, Verbist Gerlinde, Goedemé Tim (2019) Analysis of the air pollution associated with household consumption in Belgium in 2014: the case of greenhouse gas emissions, Working paper for the SUSPENS research project funded by the Federal Science Policy Office, Brussels, Federal Planning Bureau, Working paper 8-19, 47p.

Cooreman, G, Delbaere, P., Frère, J.-M., Henry, A., (2019) Duurzame voedingspatronen: modelleringsmogelijkheden met PEACH2AIRRapport voor het SUSPENS-onderzoeksproject gefinancierd door het Federaal Wetenschapsbeleid, Federaal Planbureau, November 2019.

Fransolet, A. (2019), Low Carbon Transition Processes and their reading of justice: the case of the scenarios for a low carbon Belgium. ULB/SUSPENS.

Frère, J.-M., Jottier, D., Sociale en milieudoelstellingen in een transitie naar een koolstofarme samenleving Werkdocument in het kader van het onderzoeksproject SUSPENS, Federaal Planbureau, November 2016.

Frère, J.M., Vandille, G. & Wolff, S. (2018) The PEACH2AIR database of air pollution associated with household consumption in Belgium in 2014 Methodological description for the SUSPENS research project funded by the Federal Science Policy Office. FPB Working Paper 2018-3. Brussels, March 2018.

Levay P.Z., Vanhille J., Verbist G., Goedemé T. (2019) De sociale verdeling van broeikasgassen in België, CSB-Bericht 2019/07, Antwerp: Herman Deleeck Centre for Social Policy – University of Antwerp, 14p.

Levay P.Z., Vanhille, J., Verbist, G., Goedemé T. (2020) The association between the carbon footprint and the socio-economic characteristics of Belgian households. CSB Working Paper 20/05, Antwerp: Herman Deleeck Centre for Social Policy – University of Antwerp.

Levay P.Z., Vanhille J., Verbist G., Goedemé T. (forthcoming) Environmental impact of Belgian household consumption: assessing the assumption of homogeneity of price. CSB Working Paper, Antwerp: Herman Deleeck Centre for Social Policy – University of Antwerp.

Levay P.Z., Vanhille, J., Verbist, G., Goedemé T. (forthcoming) The association between the carbon footprint and the socio-economic characteristics of Belgian households. University of Oxford INET Working Paper, Oxford: Institute for New Economic Thinking – Oxford Martin School.

Vanhille, J., Goedemé, T., Verbist, G. (forthcoming). Policy Routes towards Residential Energy Efficiency: A Social Distribution Perspective. In preparation as a CSB Working Paper, Antwerp: Herman Deleeck Centre for Social Policy – University of Antwerp.

Verbruggen, A. (2016). Sustainable Energy Transitions. www.avielverbruggen.be

Wallenborn, G. & May X. (forthcoming), Redistribution effects of future electricity tariffs. ULB/SUSPENS.

Wallenborn G. (forthcoming), Three principles of justice to deal with ecological inequalities including nonhumans. ULB/SUSPENS.

7.3 PhD theses

Vanhille, J. (forthcoming 2020) 'Trade-off or synergy? The interlinkages between social and environmental policy in the Belgian welfare state: a household perspective.'

7.4 Publications to the general public

Wallenborn G. (2020), La transition énergétique sera sociale et politique, ou ne sera pas !, La Libre Belgique, February 2020

Wallenborn G. (2019a), Gilets jaunes et jeunes fâchés : la justice est une lutte permanente, Le chou (trimestriel du Centre d'Information et d'Éducation Populaire du M. O. C. de Bruxelles) 107, March 2019.

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